

HUKILL CHEMICAL CORPORATION
BEDFORD, OHIO

CORRECTIVE ACTION
STUDY REPORT

5-90

PROJECT #495-1
MAY 1990

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1.0 INTRODUCTION

Hukill Chemical Corporation (HCC) owns and operates a chemical distribution solvent recovery facility located in an industrial park at 7013 Krick Road, Bedford, Cuyahoga County, Ohio. HCC recycles spent industrial solvents using thin film evaporators and a fractionating distillation tower. HCC has RCRA Interim Status as a storage facility and has applied for a RCRA Part B Permit.

On February 6, 1990, USEPA approved Eder Associates' "Review of Alternative Corrective Actions" report for the HCC site. This report described corrective actions to address the following remedial objectives identified during the various site investigations:

- ° Minimize the possibility that personnel could be exposed to contaminated soil in the areas of the underground cistern and the no-free liquid container storage (NFLCS) area.
- ° Prevent consumption and minimize the physical exposure to groundwater and perched water.
- ° Minimize the occurrence of perched water in the solvent tank farm area.
- ° Minimize contaminant migration from soils to groundwater.
- ° Minimize the potential for further releases of waste constituents.

These remedial objectives and the site investigation results are summarized in Eder Associates "Site Investigation Report, Revision No. 1, January 1989".

USEPA approved Alternative 5 as described in EA's "Review of Alternative Corrective Actions" report as the corrective action to be implemented to achieve the remedial objectives. Alternative 5 consists of the following corrective action elements:

1. Placing a single layer asphalt or concrete cap over the unpaved area around the NFLCS area.
2. Filling sumps in the solvent tank farm with concrete.
3. Closing the tank farm pursuant to 40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97 including a concrete cap over the base of the tank farm with a bearing capacity sufficient to support storage tanks.
4. Closing the cistern to satisfy 40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97, by backfilling the tank with clean soil, sealing the access manways with concrete and repairing cracks in the concrete pavement in the cistern area.
5. Continuing operation of the french drain system located east of the solvent tank farm, removing and disposing of contaminated perched water.
6. Installing a perched water collection system near the cistern.
7. Implementing plume management pursuant to a RCRA ACL and consistent with 40 CFR 264.94 and OAC 3745-54-94.

In addition to these corrective actions, this alternative also includes a contingent corrective action pump and treat system for groundwater downgradient of the tank farm as requested by USEPA. This contingent recovery system would only be implemented if the groundwater discharge violates the ACL limit in a statistically significant manner.

The corrective action component items 2, 3 and 4 are described in Eder Associates' January 1990 "Closure Plan for Solvent Storage Tank Farm and Underground Cistern". The Closure Plan was submitted to Ohio EPA and USEPA in January 1990 and is presently being reviewed by regulatory agencies. In addition, the concrete cap component over the

unpaved area of the NFLCS area has been installed (see drawing 1) and the french drain system is in place. These components are not addressed further in this report.

As most of the corrective action is implemented or addressed in the January 1990 Closure Plan, this report is limited to the conceptual design evaluation of three corrective actions:

1. The perched water collection system to be installed at the cistern.
2. The contingent pump and treat system for groundwater downgradient of the tank farm.
3. Plume management via the ACL.

2.0 PLUME MANAGEMENT, GROUNDWATER AND PERCHED WATER COLLECTION

The USEPA approved corrective action alternative (Alternative 5) includes plume management via an ACL, a system to collect perched water at the cistern and a contingent groundwater pump and treat system downgradient of the solvent tank farm. The conceptual design of these components is presented in this section and Section 3.0.

2.1 Plume Management

Alternative 5 allows the continued discharge of untreated groundwater to the Tinker's Creek tributary pursuant to a RCRA Alternate Concentration Limit (ACL). The possibility of human contact with groundwater would be effectively prevented through institutional controls. The use of an ACL in this manner is consistent with Federal and State Regulations at 40 CFR 264.94 and OAC 3745-54-94 and USEPA "Alternate Concentration Limit Guidance, Part 1, ACL Policy and Information Requirements," Document No. EPA/530-SW-87-017. The actual ACLs would be established through a Post-Closure Permit application pursuant to 40 CFR 265.197(b) and 270.1(c) and would ensure that there is no evident adverse impact on surface water quality.

The following factors would be considered during the design phase in developing the ACL:

1. Potential adverse effects on groundwater quality, based on:
 - a. The physical and chemical characteristics of the contaminants;
 - b. the hydrogeological characteristics of the facility and surrounding land;
 - c. The velocity of groundwater and the direction of groundwater flow;
 - d. The proximity of groundwater users and withdrawal rates.

- e. The present and probable future use of groundwater in the area;
 - f. The ambient groundwater quality, including other sources of contamination and their cumulative impact on groundwater quality;
 - g. The potential for health risks caused by human exposure to waste constituents via groundwater routes;
 - h. The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents in groundwater;
 - i. The persistence and permanence of the potential adverse effects on groundwater.
2. Potential adverse effects on surface water quality, based on:
- a. The physical and chemical characteristics of the contaminants;
 - b. the hydrogeological characteristics of the facility and surrounding land;
 - c. The quantity and quality of groundwater, and the direction of groundwater flow;
 - d. The patterns of rainfall in the region;
 - e. The proximity to surface waters;
 - f. The present and future uses of surface waters in the area and any water quality standards established for those surface waters;

- g. Surface water quality including other sources of contamination and the cumulative impact on surface water quality;
- h. The potential for health risks caused by human exposure to waste constituents via surface water;
- i. The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents via surface water;
- j. The persistence and permanence of the potential adverse effects to surface water.

HCC is presently collecting surface water quality data upstream and downstream of the groundwater discharge to develop the ACL. A contingent groundwater recovery system would be implemented if it is evident that the ACL discharge is violated on a consistent and statistically significant basis. This would exclude transient variations in discharge quality and unusual surface water flow conditions that would be expected to persist for short periods (summer time low flow, drought, etc.).

2.2 Groundwater Collection (Contingent Alternative)

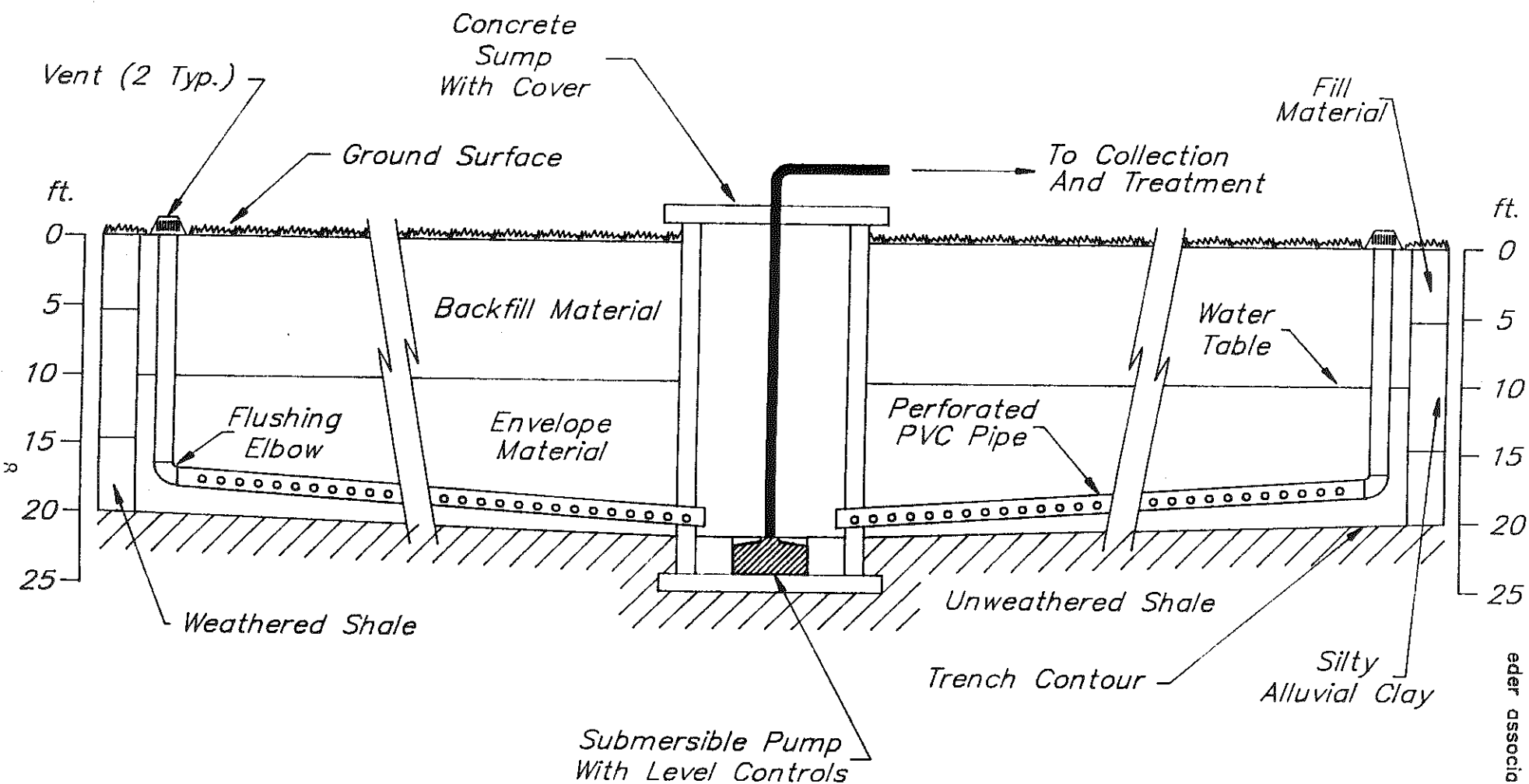
The contingent groundwater collection system would consist of a subsurface drain designed to intercept and cut-off the movement of groundwater prior to its discharge to the on-site tributary to Tinkers Creek. Since groundwater at the site occurs in silty clays - weathered shale (low permeability material), collection via drains would be more cost-effective than recovery wells. Drains would not require periodic maintenance and replacement costs would likely be less than recovery wells, assuming that the well is more complex than a wellpoint.

The proposed subsurface drain system consists of a collection trench containing a buried collection pipe. The trench would be located on the fluvial terrace of the tributary to Tinkers Creek in advance of the toe of the plume on HCC property (see Drawing No. 1). The length of the trench would be about 170 ft. based on the calculated dimension of the plume. Figure 1 shows a schematic cross section of the subsurface drain. The depth of the trench would be about 20 ft. based on the elevation of the top of unweathered shale with the exact depth determined during the design phase. The trench width would be sufficient to lay the most commonly used 4 inch diameter to 6 inch diameter perforated PVC collection pipe and would allow space for envelope material. The depth of the envelope material surrounding the drain pipe would be about 9 ft. to the water table (based on water level measurements at Well G) to improve the hydraulic conductivity between the drain pipe and the aquifer. Screened crushed bank run (0.5 - 0.75 in.) could be used as the envelope material and the volume of envelope is calculated to be approximately 100 yd³. After the envelope is placed, the trench would be backfilled using excavated clay or silty clay.

The grade of the perforated PVC collector pipe would be approximately 0.5% pitched toward a concrete sump installed in the approximate midpoint of the trench. A pump installed in the sump would transfer groundwater to the treatment system described in Section 3.0. Each end of the collector pipe would have a flushing elbow for maintenance purposes.

Based on the soil permeability data obtained during the site investigation, the collection system would probably yield less than 1 GPM from the weathered shale. Actual yield would be measured in test pit(s) during the design phase.

The subsurface drain would intercept groundwater moving towards the tributary in the area shown in Drawing No. 1. Some groundwater may migrate to the tributary in the approximate 100 ft. area between Wells C and SW-3. A collection trench in this area is not practical



CROSS-SECTION OF SUBSURFACE DRAIN

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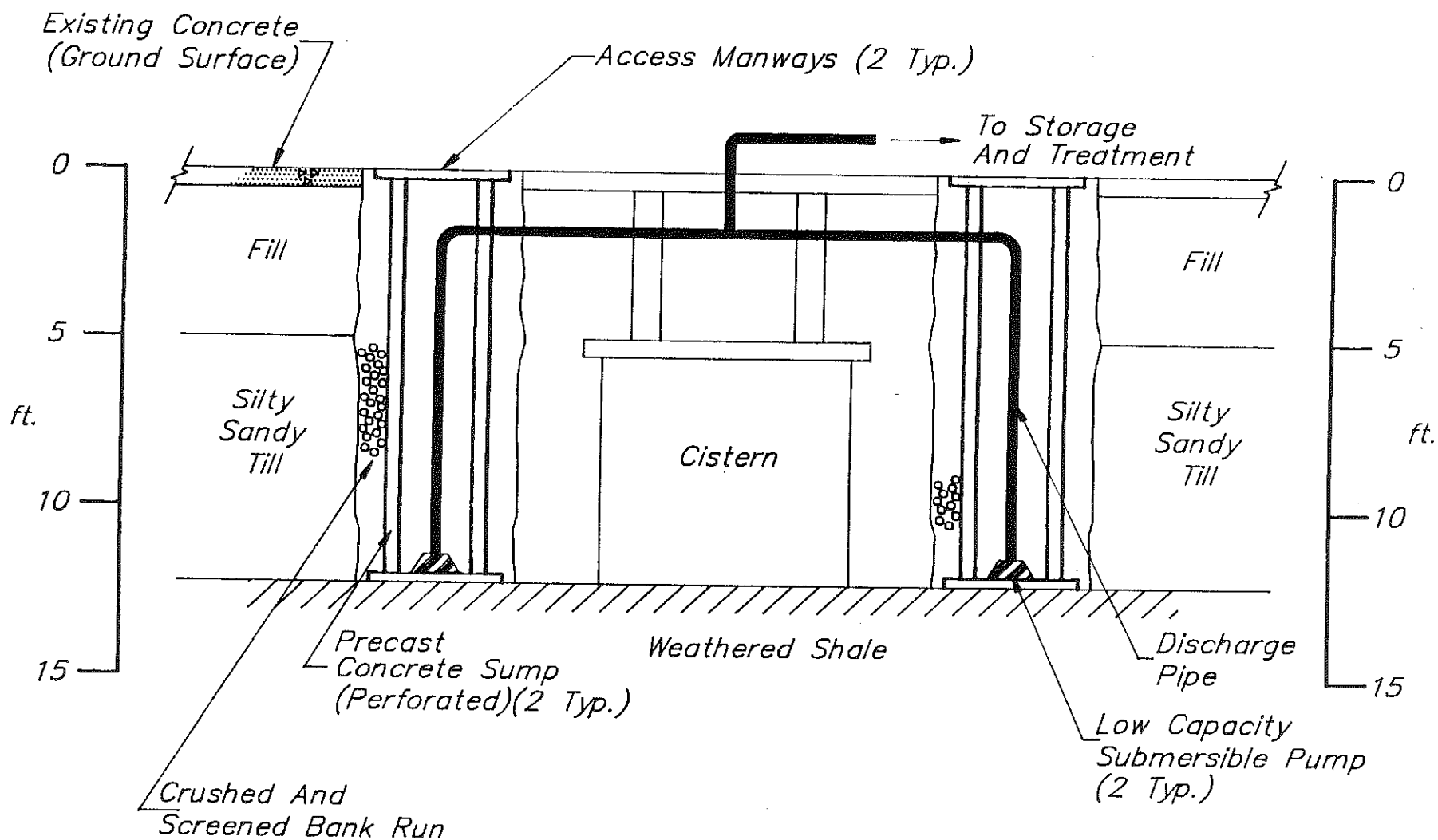
because it would have to be approximately 40 ft. deep to accommodate the higher surface grade elevation in this area. Moreover, because of the very low permeability of the unweathered shale and the consequent very low yield, using recovery wells in this area would not be feasible and the expense would convey no material benefit.

2.3 Perched Water Collection

The underground cistern is surrounded by approximately 5 ft. of fill composed of sand, silt and gravel extending to the weathered shale bedrock. Below this fill is a silty, sandy till which lies above the weathered/fractured shale. The bottom of the cistern rests on this shale bedrock at a depth of 13 ft. Perched water was found in the cistern and above the shale bedrock at 12 to 13 ft. below land surface. The cistern would be closed pursuant to EA's January 1990 "Closure Plan for Solvent Storage Tank Farm and Underground Cistern."

Alternative 5 includes a perched water collection system consisting of two perforated concrete sumps installed in the immediate vicinity of the cistern. Figure 2 shows a cross section of the collection system.

Bucket augers would be used to drill approximately 48 in. diameter holes to the top of the shale bedrock. A pre-cast concrete base will be installed in the augered holes and would rest on the top of the shale bedrock. A pre-cast perforated concrete sump would be installed on the base. The annulus between the augered hole and the sump will be backfilled with crushed and screened bank run to grade. A submersible pump installed in each sump would discharge to the treatment system described in Section 3.0.



CROSS-SECTION OF THE CISTERN PERCHED WATER COLLECTION SYSTEM

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3.0 TREATMENT

3.1 Treatment Load

Groundwater collected at the subsurface drain downgradient of the tank farm and perched water collected around the cistern would be pumped to a storage tank, treated and discharged to the sanitary sewer or stored and hauled off-site for treatment. The alternative selected by HCC would depend on the prevailing comparative cost of the alternatives and HCC may choose to implement one or the other, or possibly both alternatives depending on cost. The following discussion relates to the on-site treatment alternative.

The estimated flow rates are 1 gpm from the drain and 0.2 gpm from the cistern. These flow rates would be verified by pilot testing during the design phase. The estimated total flow rate of 1.2 gpm would be pumped to a 12,500 gal. minimum volume holding tank which would provide an approximate one week detention time. Treatment would be done over an 8-hour workday shift at an approximate flow rate of 4 gpm.

Groundwater contains concentrations of iron and organic chemicals that exceed the sanitary sewer discharge standards. Table 1 summarizes chemicals found in samples from Well G, chemicals found in cistern water, and the concentrations expected in the recovered groundwater. The average design concentrations expected in the recovered groundwater were obtained by a mass balance calculation. The preliminary design concentrations are based on a safety factor of 2.

3.2 Treatment Process

The treatment process would be designed to reduce iron and organic chemical concentrations to meet the sanitary sewer discharge standards (50 mg/l and 250 mg/l respectively). Iron must be removed from the water because it will interfere with the treatment of organics. Iron in groundwater typically exists as soluble ferrous iron (Fe(II)). At

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TABLE 1

SAMPLING RESULTS

Parameter (mg/l)	Well G					Cistern	Average ⁽¹⁾ Cistern & Well G	Preliminary ⁽²⁾ Design
	Sept/Oct 86	Feb 87	Apr 88	Sept 89	Average			
<u>Organic Chemicals</u>								
Methylene Chloride	270	730	280	180	365	1,300	520	1,000
Acetone	---	730	---	18	190	980	320	600
2-Butanone	---	---	7	5	3	360	63	<u>120</u>
							TOTAL	1,720
<u>Inorganic Chemicals</u>								
Iron	N/A	N/A	131	N/A		N/A		

Notes:

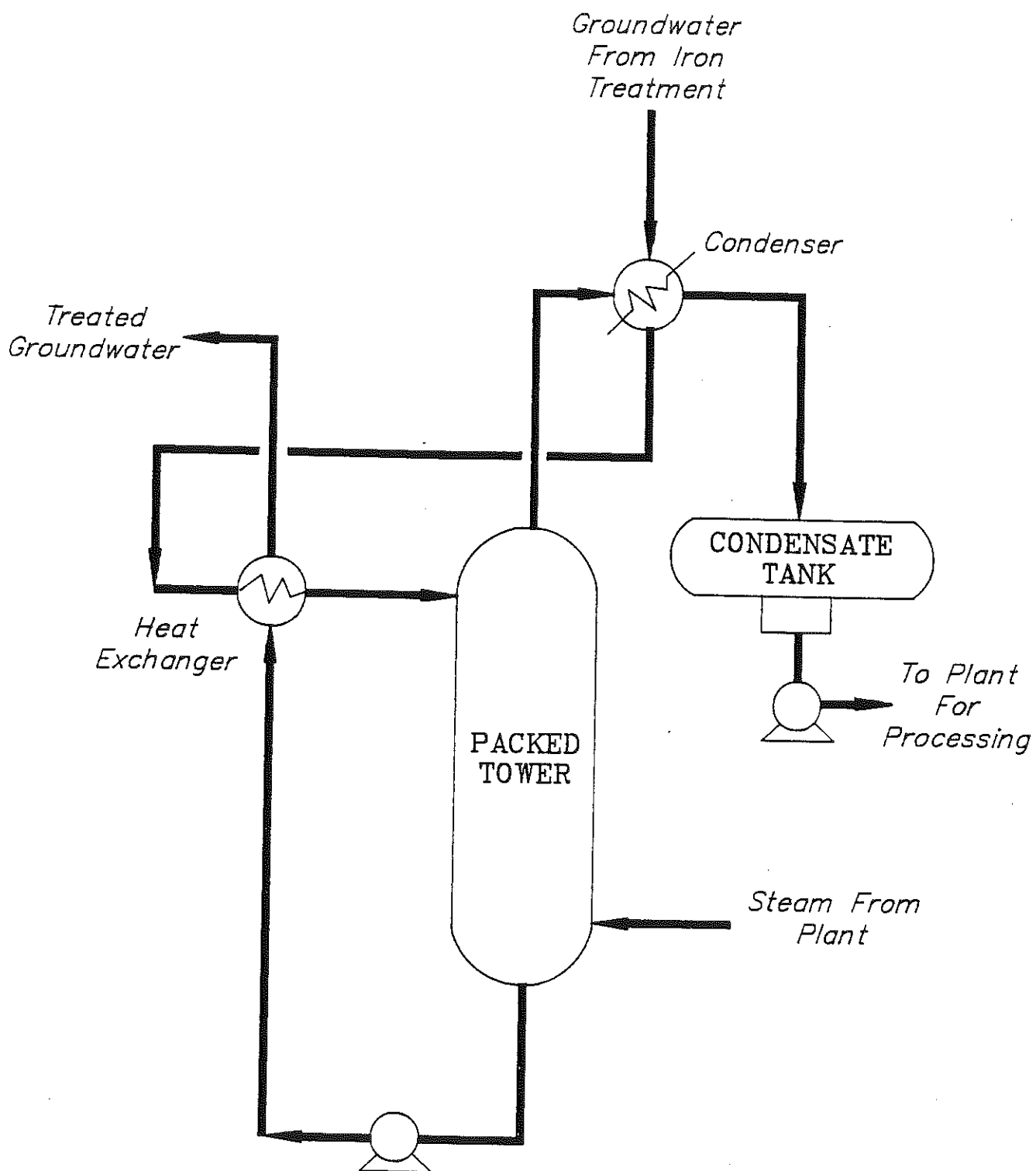
- (1) From mass balance calculations
- (2) Using a safety factor of 2
- Chemical not found
- N/A Sample not analyzed

neutral pH and in the presence of oxygen, ferrous iron rapidly oxidizes to ferric iron (Fe(III)), which readily hydrolyzes to form ferric hydroxide, $\text{Fe}(\text{OH})_3$, an insoluble precipitate which can precipitate in piping and treatment equipment causing costly maintenance and operational problems. Oxidizing the iron is accomplished by aeration or by adding sodium hypochloride at a neutral pH. If the ferric hydroxide generated in this reaction does not precipitate fast enough, a polymer can be added. Residual solids in suspension after precipitation will be removed by filtration. Pilot testing will be necessary to determine the iron treatment efficiency and the need for polymer and subsequent filtration.

Assuming that the iron is removed, the treatment technologies are effectively limited to air stripping with activated carbon adsorption, and steam stripping. Air stripping/activated carbon adsorption would effectively remove the chlorinated hydrocarbons but not the ketones because they are more soluble in water than chlorinated hydrocarbons. These limitations eliminate air stripping/carbon adsorption from further evaluation because the process cannot accommodate the entire waste stream.

Steam stripping is the cost-effective treatment alternative which will remove ketones as well as chlorinated hydrocarbons. Figure 3 shows the steam stripping process. Feed water would be preheated by absorbing heat from the vapors at the condenser, and then by using the heat of the treated liquid effluent from the packed tower. Steam would flow countercurrent to the falling liquid. The vapors from the tower would be condensed and pumped to HCC's solvent recovery plant for processing. The higher temperatures of the steam stripping process would strip organic compounds that would not normally be removed by conventional air stripping. Other major benefits of steam stripping include the recovery of contaminants as virtually pure chemicals without the need to accommodate air discharge limitations since the vapors are condensed.

FIGURE 3



STEAM STRIPPING PROCESS

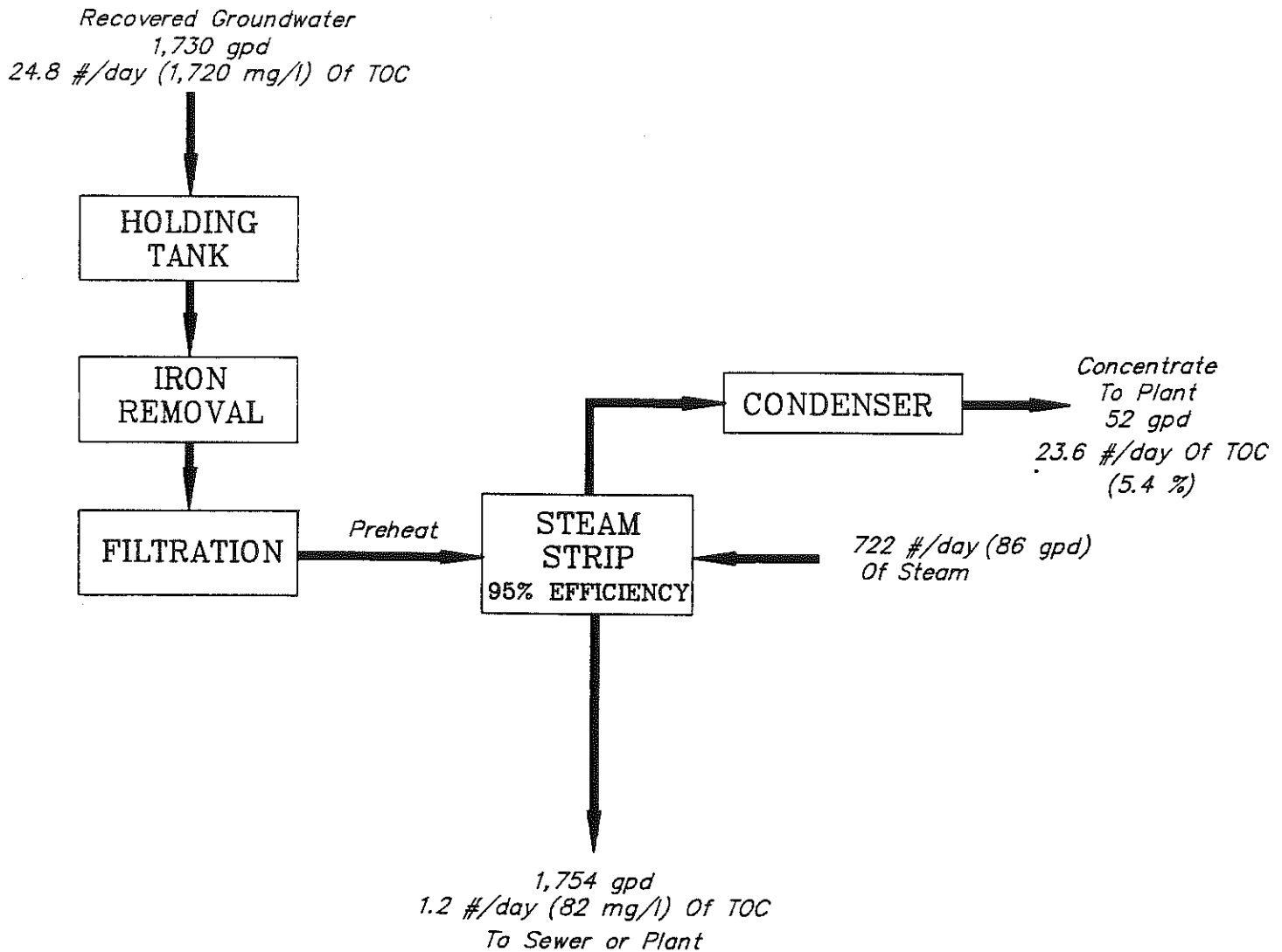
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Based on preliminary calculations at a flow rate of 4 gpm, the steam stripping tower would be 10 inches in diameter and 30 feet high. The required steam would be approximately 90 lbs/hour (for an 8-hour period). Approximately 40 percent of this steam will condense with the influent and would be discharged with the treated feed water. At a removal efficiency of 95% the concentration of total organics in the effluent would be about 82 mg/l, which is significantly less than the 250 mg/l required for sewer discharge. A pilot study would be performed to obtain performance data using on-site feed water.

Figure 4 shows the proposed groundwater treatment and disposal system with the total organic load in each process stream. The overhead steam condensate rate (from condenser) is about 60 percent of incoming steam. This steam condensate rate is 52 gpd. The condensed steam would contain approximately 5.4% total organics and it could be incorporated into the HCC waste solvent feed for recovery.

Treatment system effluent would pass through a heat exchanger to lower its temperature prior to discharge to the sewer or the heated water could be used as process water at the HCC plant. This would eliminate the sewer discharge and the need for a sewer discharge permit and monitoring.

FIGURE 4



Note—

TOC = Total Organic Chemicals

GROUNDWATER TREATMENT

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4.0 GROUNDWATER COLLECTION AND TREATMENT COST

Table 2 shows the estimated preliminary capital cost breakdown to construct the groundwater collection, treatment and disposal system. The total estimated capital cost is \$269,000. Table 3 shows the estimated annual operating cost breakdown of the system. The estimated cost is \$43,000/year.

All system costs would be further evaluated following pilot tests conducted during the design phase.

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TABLE 2

GROUNDWATER COLLECTION
AND TREATMENT SYSTEM
PRELIMINARY CAPITAL COST ESTIMATE

<u>Item and Description</u>	<u>Cost</u>
1. Subsurface drain with sump collection	\$ 10,000
2. Cistern collection system	5,000
3. Holding tank (12,500 gal)	13,000
4. Iron removal system with pumps	20,000
5. Filtration Equipment	2,000
6. Steam stripping tower (including condenser)	100,000
7. Heat exchanger	5,000
8. Pilot Studies:	
i) iron removal	10,000
ii) steam stripping	20,000
9. Piping	10,000
10. Pumps and controls	10,000
11. Electrical	<u>10,000</u>
12. SUBTOTAL	\$215,000
13. Contingencies and Engineering (@ 25%)	<u>54,000</u>
14. TOTAL	\$269,000

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TABLE 3

ESTIMATED ANNUAL OPERATION AND MAINTENANCE COST

<u>Item and Description</u>	<u>Cost</u>
1. Maintenance	\$15,000
2. Groundwater and Treated Effluent Sampling ⁽¹⁾ and Laboratory Analysis	10,000
3. Treatment System Operator (2 hours/day)	15,000
4. Electrical	1,000
5. Steam	<u>3,000</u>
TOTAL	\$43,000

NOTES:

(1) Sampling by trained HCC personnel.

5.0 APPLICABLE FEDERAL, STATE AND LOCAL LAWS

The Federal, State and local laws applicable to the corrective actions (including the contingent pump and treat system) are summarized in Table 4. Plume management would be implemented pursuant to the Alternate Concentration Limit (ACL) provision of 40 CFR Subpart F and OAC 3745-54-94. Perched water and groundwater would be collected and treated pursuant to Federal and State hazardous waste regulations and would be treated to comply with the effluent limitations established by the Northeast Ohio Regional Sewer Ordinance. Construction Activities would be implemented in accord with Occupational Safety and Health Administration (OSHA) regulations.

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TABLE 4

FEDERAL, STATE AND LOCAL REGULATIONS
APPLICABLE TO CORRECTIVE ACTIONS

<u>Regulation</u>	<u>Citation</u>	<u>Description</u>
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262 OAC 3745-52	Establishes standards for RCRA generators.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, & Disposal Facilities	40 CFR Part 265 OAC 3745-65-10 through OAC 3745-69-30	Establishes minimum standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.
°General Facility Standards-Financial Requirements	Subparts B through H OAC 3745-65-10 through OAC 3745-66-48	
°Tanks	Subpart J OAC 3745-66-90 through OAC 3745-66-992	Establishes standards for use of tanks to treat or store hazardous wastes.
°Releases from Solid Waste Management Units	Subpart F OAC 3745-54-90 through OAC 3745-54-99	Establishes groundwater protection standards for releases of hazardous constituents
Occupational Safety and Health Act	29 U.S.C. §§ 651-678	Regulates worker health and safety
Northeast Ohio Regional Sewer Ordinance		Establishes effluent limitations for discharges to POTWs

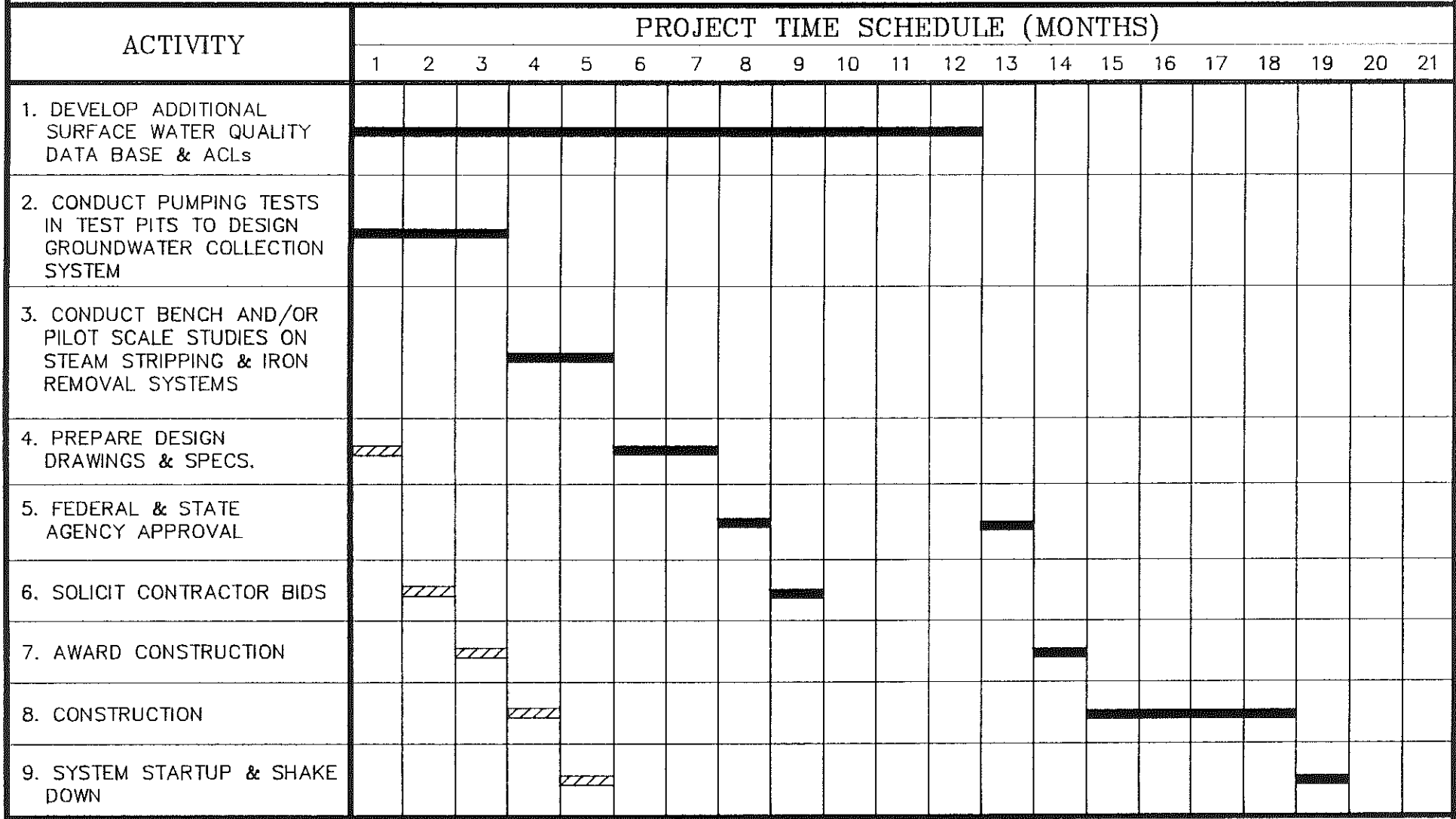
6.0 IMPLEMENTATION SCHEDULE

The estimated time to implement the selected corrective actions including the contingent pump and treat system for groundwater downgradient of the tank farm is shown in Figure 5. The ACL required for plume management can be developed within approximately 12 months. The perched water collection system at the cistern can be installed within approximately five months of agency approval of this report and of EA's "Closure Plan for Solvent Storage Tank Farm and Underground Cistern" submitted to OEPA and USEPA in January 1990.

The contingent pump and treat system would be designed concurrently with the development of the surface water quality data base and the ACLs, however, this contingent pump and treat system would be implemented only if the groundwater discharge to surface water causes ACL exceedances on a statistically significant basis. In such an event, the contingent pump and treat system could be implemented within 6 months of detecting the ACL exceedances, weather permitting.

IMPLEMENTATION SCHEDULE

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//// CISTERN PERCHED WATER COLLECTION SYSTEM

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7.0 HEALTH AND SAFETY PLAN

The health and safety plan to protect personnel during implementation of the corrective actions is outlined in Table 5.

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TABLE 5

HEALTH AND SAFETY PLAN OUTLINE

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 - Key Personnel
 - Responsibilities
- 3.0 Hazard Assessment
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 - Public
- 4.0 Personal Protective Equipment
 - Respiratory Protection
 - Protective Clothing
 - Special Protective Equipment
 - Emergency Equipment
- 5.0 Training Programs and Medical Surveillance
- 6.0 Decontamination Procedures
 - General Considerations
 - Specific Guidelines
- 7.0 Site Controls
- 8.0 Monitoring
 - Air Monitoring
 - Required Analytical Work
 - Chain-of-Custody
- 9.0 Reports and Recordkeeping
 - Daily Log and Progress Reports
 - Sampling/Air Monitoring Log and Documents
 - Incident Reports
- 10.0 Emergency Procedures
 - Project Personnel Responsibilities
 - Emergency Equipment Available
 - Emergency Contacts
 - Medical Emergencies
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1.0 INTRODUCTION

Hukill Chemical Corporation (HCC) owns and operates a chemical distribution center and solvent recovery facility located in an industrial park at 7013 Krick Road, City of Bedford, Cuyahoga County, Ohio. HCC recycles spent industrial solvents using two thin film evaporators and a fractionating distillation tower. HCC has RCRA Interim Status as a generator and storage facility and has applied for a RCRA Part B Permit. A site plan is included in Appendix A (Drawing No. 1). A detailed description of facility operations is provided in the Part B Permit application. Site and regional topographic maps are also provided in the Part B application.

The purpose of this Alternative Corrective Actions Study is to identify, evaluate and select remedial alternatives which minimize the possibility of current and future threats to public health and the environment from the solvent tank farm, the underground cistern, the API tank basin, the storm water collection system and the no-free liquid container storage (NFLCS) area in a cost-effective manner. These units and the nature of their associated groundwater and soil impacts are described in detail in the January 1989 Site Investigation Report.

The Site Investigation Report identified the following remedial objectives:

- Minimize the possibility that personnel could be exposed to contaminated soil in the areas of the underground cistern and at the NFLCS area.
- Prevent consumption and minimize physical exposure to groundwater and perched water at the site.
- Minimize the occurrence of perched water in the tank farm area.

- Minimize contaminant migration from soils to underlying groundwater.
- Minimize the potential for further releases of waste constituents.

In June 1989, this "Review of Alternative Corrective Actions" report was submitted in draft to United States Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA). USEPA and OEPA comments on the draft report were presented in July 21, 1989 and October 27, 1989 letters respectively and these comments were resolved at a November 7, 1989 meeting attended by representatives of USEPA, OEPA, HCC and Eder Associates Consulting Engineers, P.C. (EA). The major items agreed to at the meeting were summarized in EA's November 22, 1989 (Appendix B) letter to USEPA. On December 8, 1989 (Appendix B) USEPA requested that EA modify "Review of Alternative Corrective Actions" Report. This revision includes these modifications.

Summary Description of Site Areas

The following subsections describe the areas investigated at the HCC facility and which are the subject of this correction action study. The locations of the units are shown in Drawing Nos. 1, 2 and 3 in Appendix A.

Solvent Tank Farm

Reclaimed and waste solvents are stored in aboveground steel tanks in a bermed tank farm which consists of two sections. Only the west or old section was used to store reclaimed and waste solvents until January, 1988. In January 1988, HCC completed construction of the east section of the tank farm to store hazardous waste materials in compliance with secondary containment requirements for hazardous waste. The southern berm of the west section is masonry with earthen materials forming the remainder of the berm to a height of

approximately four feet. The base of this section of the tank farm is gravel underlain by clay till.

There are two pipe galleys in the west section of the tank farm installed in the north-south directions. One pipe galley runs at approximately grade elevation and penetrates the masonry berm in the southwest corner of the tank farm. The second pipe galley is routed over the four foot high masonry berm in the southeast corner of the tank farm.

The west section of the tank farm area is dewatered by pumping accumulated precipitation from two collection sumps; one located in the northeast corner, the other in the southwest corner of the tank farm.

The east section of the tank farm was constructed with 3 foot high concrete walls and an 8 inch thick concrete floor. Piping to this section of the tank farm runs in a east-west direction at the southwest corner of this section. The east section of the tank farm is dewatered by pumping accumulated precipitation from a concrete sump located in the southeast corner of the tank farm.

Underground Cistern

A precast concrete cistern was installed underground around 1975 east of the HCC facility buildings. Floor drains and collection trenches located in the HCC processing building were connected to the cistern which served as a gravity fed secondary spill containment storage tank. Floor drains and trenches connected to the cistern were sealed in 1982. Drawing No. 2 shows the cistern piping in the process building.

No-Free Liquid Container Storage Area

This area is located to the east of the HCC facility building and is used to store 55 gallon drums which do not contain free liquid.

Drums are stored on a concrete pad which is surrounded on the south and eastern boundaries by a six inch high concrete curb.

API Tank Basin

An underground 10,000 gallon API separator tank was located to the east of the solvent tank farm and a containment basin for storm water runoff was located above the API tank. The depth at the center of the basin was approximately 4 ft. In August 1988, the API tank was removed from service and the tank excavation was backfilled. The tank was used as the collector for a french drain system installed to collect subsurface seepage that could migrate in an easterly direction from the tank farm. The french drain is located to the east of the solvent tank farm (Drawing No. 3). The API tank was also used to store storm water collected in a 1,500 gallon tank (Drawing No. 3) connected to the storm water collection system. Storm water was transferred to the API tank during dry weather. The french drain system now discharges to a sump which was installed in the former area of the API tank. The sump contents are pumped to one of the facility's permitted storage tanks. HCC plans to modify the API tank and connect it directly to the facility storm sewer near the 1500 gallon tank which would provide an additional 10,000 gallons of spill containment capacity.

Storm Water Collection System

The HCC facility has a storm water sewer collection system which diverts storm water to Outfall No. 001 located east of the Hukill facility buildings at the tributary to Tinkers Creek. The discharge to the tributary is regulated by a State NPDES permit. Drawing No. 3 shows the layout of the storm water collection system.

2.0 GENERAL RESPONSE ACTIONS AND TECHNOLOGIES

The following general response actions have been identified based on the results of the site investigation conducted at HCC. A no action alternative is included as a baseline against which other actions can be measured:

- no action
- containment
- collection
- excavation
- soil treatment
- groundwater treatment

A summary of the general response actions and the applicable technologies which can satisfy the corrective action objectives are presented in Table 1.

Technology Screening Criteria

This section identifies, describes and screens technologies that may be applicable to the HCC site, based on the following retain/reject criteria:

- a. There must be a demonstrated history of successful use of the technology in environments similar to the HCC site. All technologies of a research and development nature, and which cannot be reasonably said to be field proven and in common use, are rejected.
- b. Technologies that are not relevant to site specific problems or that cannot be applied because of physical constraints or that will tend to have uncertain outcomes because of physical constraints are rejected.

HUKILL CHEMICAL CORPORATION
BEDFORD, OHIO

TABLE 1

ENVIRONMENTAL MEDIA-GENERAL RESPONSE
ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

<u>Environmental Media</u>	<u>General Response Action</u>	<u>Associated Technologies</u>
S, G	No action	Site monitoring
S	Containment	Capping
G	Containment	Capping, horizontal and vertical barriers
G	Collection	Groundwater pumping
G	Treatment	Air stripping, carbon adsorption, steam stripping, distillation, UV photolysis, biological
S	Excavation	Complete excavation Partial excavation Off-site disposal/on-site disposal
S	Treatment	Bioreclamation, soil flushing, radio frequency heating, soil vapor extraction vitrification, solidification, incineration, thermal extraction

NOTES:

S = Soil

G = Groundwater

- c. Technologies that may cause other environmental or health related impacts when applied are rejected.
- d. Technologies which have or imply an overly long period between implementation and remedial effect or which have long permitting delays before implementation are rejected unless there is no other alternative that can achieve the remedial objective in a more time-effective manner.
- e. Technologies which are or must be implemented in concert with (or are linked to) another technology which is rejected are also rejected.

Discussion of General Response Actions & Corrective Technologies

2.1 Containment

Capping - A cap minimizes infiltration and the possibility of soil contact. Capping is a proven and reliable technique to reduce contaminant migration. Natural soil, admixed soils, or synthetic caps can be constructed over almost any site condition using generally available road construction equipment.

Single layer caps composed of concrete or bituminous asphalt are extremely effective. A multi-layer cap consisting of an upper layer of topsoil over a drainage layer composed of sand, followed by a low permeability layer formed by soil or a synthetic liner material functions by diverting rain water infiltration from the surface vegetative layer through the drainage layer and away from the underlying waste material. The performance of a properly installed multi-layer cap is generally excellent provided periodic maintenance is performed to remedy the effects of settling and penetration of the cap by deep rooted plants. The single layer asphalt or concrete cap is as effective as a multi-layer RCRA cap and does not preclude the use of the covered area in load bearing activities.

Flexible synthetic membranes are often used as caps. Membrane caps are typically made from polyvinyl chloride (PVC), hypalon, chlorinated polyethylene (CPE) and butyl rubber. The underliner base for these materials usually consists of fine to medium grade fill which will support the weight of the material and minimize the risk of puncturing. The minimum thicknesses of a synthetic membrane used as a cap is generally 20 mil.

Natural clay soils are also used as caps. Standard design practice for a natural clay liner requires a permeability of less than or equal to 1×10^{-7} cm/sec, with not less than 50% of the soil particles passing the number 200 sieve. When sufficient fine grain soils are not available to achieve the design permeability, clay material, such as bentonite, can be mixed with on-site soil to achieve the desired permeability.

2.2 Groundwater Containment and Collection

Soil-Bentonite Slurry Wall - Subsurface vertical barriers which redirect groundwater flow can be an effective source control measure when combined with other measures, providing the geology of a site is favorable. Soil-bentonite slurry walls have been used to control seepage around dams because they are relatively easy to construct and are effective in controlling groundwater flow, however they must be keyed into a low permeability formation to ensure reliability. A thorough compatibility test between the grout mixture and contaminants present in the groundwater would also be necessary to ensure that the system would be reliable.

Hanging slurry walls are not tied into a confining layer but extend several feet into the water table as a barrier to floating contaminants such as oil, fuel and migrating gases. The use of hanging slurry walls in site remediation or closure is not common, and would not be applicable to the HCC site.

Steel Sheet Piling - Steel sheet piling can be installed as a vertical barrier to impede groundwater flow. Sheet piling walls tend to leak at seams or interlocks after installation and, with time, soil particles generally seal the seams. Because of its cost and unpredictable wall integrity, the use of steel sheet piling is generally limited to temporary dewatering applications in construction or as erosion protection devices. This technology is eliminated from further consideration.

Horizontal Barriers - A flow barrier can sometimes be constructed by grout injection and is usually installed in conjunction with a vertical barrier. The volume and distribution of the injected slurry must be sufficient to ensure a continuous bottom barrier between injection points. The reliability of bottom sealing techniques is not sufficiently documented in field situations, and the method is eliminated from further consideration.

Pumping - Groundwater pumping involves the installation of wells or collection trenches which are pumped to contain or remove groundwater. Extraction wells, a combination of extraction and injection wells or collection trenches can be used to contain and remove a contaminant plume. The function of the injection well is to direct the contaminant to the extraction well or collection trench. The use of extraction wells alone is more suited to situations where the hydraulic gradient is steep and the hydraulic conductivity is high.

The combination of extraction and injection wells is typically used in situations where the hydraulic gradient is relatively flat and the hydraulic conductivity is moderate.

Groundwater recovery wells or collection trenches at the HCC site would be located within or at the edge of the plume and the recovery system could be implemented within a short time. Since groundwater at HCC occurs in a zone of fractured and weathered shale with low yield, multiple recovery wells would be required. A pumping test would be necessary to determine if the shale can be pumped at a reasonable rate

and to estimate the number of recovery wells. Given a sufficient number of wells, it should be possible to modify the prevailing hydraulic gradient and cut off the plume.

As an alternative to recovery wells, collection trenches may be possible at sites where the depth to groundwater is approximately 10 feet or less. A collection trench to intercept groundwater flow at HCC would be approximately 250 feet long and would be constructed between approximately Well SW-3 and outfall 001. Construction would require a trench depth of up to approximately 40 feet over a length of approximately 150 feet in the vicinity of Wells G to SW-3 and the trench would be approximately 15 ft between Well G and outfall 001. The trench would be extremely difficult to construct and would require a longer implementation time than recovery wells. A collection trench at the HCC site would be highly susceptible to plugging with fines which are difficult to remove and this would present a major constraint on the long-term effectiveness of this type of collection system. Recovery wells would be less susceptible to plugging and would be easier to maintain over the long term. Because of site conditions and questionable long-term effectiveness, collection trenches are not considered further.

2.3 Excavation

Excavation and Removal - The excavation and removal of contaminated soil at waste sites is generally accomplished with conventional heavy construction equipment and the methods are applicable to most site conditions. Excavated soil would be treated and disposed of on or off-site. Typical excavation equipment includes backhoes, cranes and attachments (draglines), dozers and loaders. Typical backhoes have maximum excavation depths ranging from 22 to 45 feet with a maximum boom reach ranging from 35 to 70 feet. Drag lines have maximum digging depths typically ranging from 12 to 30 feet and a digging reach ranging from 40 to 68 feet. Equipment used to transport materials on-site and off-site include scrapers and haulers. Scrapers are used to remove and haul surface cover material and to spread and compact cover soils. Trucks used to transport excavated materials vary in capacity from one to 100 tons. Equipment requirements include

backhoes and bulldozers for excavation at the cistern area, solvent tank farm and NFLCS area.

Excavating all the impacted soils at the HCC site would not be possible because of the numerous storage tanks and buildings located in impacted areas. Excavation in limited areas is possible and removing contaminated soils may reduce the contact risk and leachate generation. However, since excavation would be limited, the significance of the reduction must be established when determining the cost effectiveness of this technology.

Disposal - Excavated soils could be disposed of at an off-site RCRA landfill or in an on-site RCRA landfill. Pretreatment of the soil may be necessary to comply with Federal Land Disposal Restrictions. Off-site disposal could be implemented in a relatively short period, however, an off-site landfill could become a future compliance problem and the alternative implies long-term risks to Hukill and the public without compensating benefit. Moreover, as of November 8, 1990, material removed from the site for off-site disposal will have to comply with the RCRA Land Disposal Restrictions (Land Ban). Based on results of TCLP testing of soils at HCC, pretreatment by off-site incineration would probably be necessary to comply with these regulations. A RCRA landfill could be constructed on the HCC site. The limited on-site area would require that any landfill be located in the northwest fill area. Obtaining the required permits for a RCRA landfill would delay the implementation of the corrective action plan without offsetting benefit and the on-site RCRA landfill option is rejected.

2.4 Soil Treatment

2.4.1 In-Situ Treatment

Soil Flushing - Soil flushing is a process that floods soil with a solvent and then recovers the elutriate by pumping a series of shallow capture wells. The feasibility of the process depends upon the

ability of the solvent to mobilize the chemical of concern into a solvent phase and its successful recovery during pumping. Soil flushing has been used to extract contaminants from chemical spills and has been used effectively to remove herbicides and trichloroethylene.

Because of the low hydraulic conductivity of the fill material and the underlying till and fractured shale at the HCC site, recovering the flushing solvent would be virtually impossible and this remedial technology is eliminated from further consideration.

Bioreclamation - Bioreclamation is an in-situ or aboveground method which utilizes biological activity to degrade organic constituents. In use, environmental conditions are altered to enhance the microbial metabolism potential of soils and groundwater. Research in this emerging technology has shown that under certain conditions, biological activity can break down many non-halogenated organic compounds. The bioreclamation method that has been most developed and is most feasible for in-situ treatment is one which relies on aerobic (oxygen-requiring) microbial processes. The literature indicates that this method is not effective in degrading the halogenated organics found at HCC. These organics have been anaerobically degraded at laboratory scale, however the technology cannot be said to be field proven or in widespread use.

The feasibility of the method depends on the site specific hydrogeology. The hydraulic conductivity of soils must be great enough and the residence time short enough so that the biological matrix, oxygen and supplemental nutrients are not exhausted before they are dispersed throughout the treatment zone.

Because the hydraulic conductivity of the fill material and till at the HCC site is low and the effectiveness of anaerobic bioreclamation in the site specific context is uncertain, the technology is eliminated from further consideration.

Radio Frequency Heating - The radio frequency (RF) heating process has been under development since the 1970's and field experiments have been conducted to recover hydrocarbons. The method involves energizing a row of horizontal conductors on the surface with an RF generator. Decontamination is accomplished over a temperature range of 300° to 400°C, assisted with steam, with a required residence time of about two weeks. A gas or vapor recovery system is required at the surface. Preliminary design and cost estimates for a mobile RF in-situ decontamination process indicate that the method could be applied to certain sites and yield comparable results at 25 to 50% of the cost of excavation and incineration. This method has been field tested and appears promising for certain situations involving volatile organic compounds. The method is developmental and is eliminated from further consideration.

Soil Vapor Extraction - Soil vapor extraction consists of applying a vacuum to the soil through extraction wells perforated above the water table to remove volatile organics from the vadose zone. The vacuum is applied to the soil. A successful Vapor Extraction System (VES) requires that the organics be volatile at ambient temperatures and that the contaminated soils be sufficiently permeable to allow a significant volume of air to flow through the zone of contamination under a modest vacuum.

The relatively impermeable characteristics of the fill and till at the HCC site makes vapor recovery infeasible and this technology is eliminated from further consideration.

In-Situ Vitrification - In-Situ Vitrification (ISV) is a thermal treatment process to convert contaminated soil into a chemically inert and stable glass and crystalline matrix. Battelle Pacific Northwest Laboratories has proposed this technique for evaluation in the EPA Superfund Innovative Technology Evaluation (SITE) Program. ISV technology is based on the use of high current heating in the range of 1600 to 2000°C to destroy organic pollutants by pyrolysis and to immobilize inorganic pollutants immobilized within a vitrified mass.

Airborne organic and inorganic combustion by-products would be collected in a negative pressure hood which draws the contaminant-air mixture into a treatment system to remove particulates and other pollutants.

The typical ISV system consists of four electrodes driven into the soil and energized by applying current and voltage ranging from 400V to 4000V and 400A to 4000A. Present technology can vitrify a 25 ft x 25 ft x 50 ft volume of soil or sludge over a period of seven to ten days. The system is then moved to a second location adjacent to the first and the process is repeated until the entire soil or sludge volume has been vitrified.

The vitrification process has not been widely used in actual field situations. ISV at HCC would require implementation adjacent to and under facility structures, equipment and storage tanks. It may adversely impact the structural stability of soils and reactions in soils may occur over time which would result in failure of facility structures, equipment and storage tanks containing flammable solvents. ISV would present significant safety threats at the HCC site where flammable solvents are stored and processed. This technology is therefore eliminated from further consideration.

Solidification - Soil solidification or stabilization alters the physical and/or chemical state of the hazardous constituents within the soil to render them less leachable, less toxic, more easily handled, transported and disposed. At this time, the technique is limited to inorganic constituents. The primary constituents of concern at the HCC site are organic and this technology is excluded from further consideration.

Incineration (Thermal Destruction of Hazardous Wastes) - Incineration is an established, but costly, means to destroy organic constituents. A number of incineration technologies, including liquid injection incinerators, rotary kilns, fixed and multiple hearth incinerators and fluidized-bed incinerators have been used to destroy certain RCRA hazardous wastes.

Regulatory concerns associated with incineration of halogenated organic wastes include destruction efficiencies, limitations on the generation of toxic air emission by products and the disposal of toxic residue and ash generated as an incineration by product.

Incineration costs are higher than most hazardous waste management technologies because of the large energy input requirements and the cost of environmental controls. Costs vary widely depending on waste characteristics, incinerator design, and various operational considerations.

Any incineration facility constructed on the site would be subject to a full scale evaluation of design and performance which includes trial burns. This evaluation and the required permits results in a very long lead time, on the order of several years prior to start-up. The on-site incinerator technology is not considered further. Off-site incineration is retained for consideration and may be required to comply with Federal Disposal Restrictions prior to landfilling contaminated soil at an off-site location.

Thermal Extraction - One of the technologies investigated by the USEPA on a laboratory scale for the treatment of hazardous wastes and contaminated soil is low-temperature thermal desorption. The capability of low temperature thermal desorption technology to remove volatile and semivolatile contaminants was investigated by preparing a synthetic soil spiked with predetermined quantities of contaminants. The EPA found that desorption of volatile and semivolatile organics could be achieved by heating soils at temperatures less than 550°F.

A nominal five (5) TPD (tons per day) prototype system has been built by Chemical Waste Management (CWM). The company claims that this system provides a simpler, environmentally attractive and substantially lower cost alternate to incineration for extracting organics. A full scale unit, rated at a nominal 125 TPD, will be built by CWM and the company plans to complete the scale unit with a 125 TPD throughput rate in 1989.

The thermal extraction process is not field proven and is not in widespread use. It is not considered further for the treatment of soils at the HCC site.

2.5 Groundwater Treatment

The following technologies are used to treat aqueous wastes and are evaluated for treating groundwater at HCC including perched water.

Carbon Adsorption - Activated carbon treatment is effective in removing chlorinated hydrocarbons and other mixed organic chemicals from groundwater via surface adsorption, however, it is not effective in removing small molecular compounds such as acetone. Pilot tests are usually required to accurately predict field performance and operating costs. Carbon treatment is not particularly sensitive to changes in concentration and is not adversely affected by toxics, however, it is susceptible to biological growth or fouling from solids buildup.

The replacement or regeneration of spent carbon is a major maintenance consideration and high capital and operating costs are a major limitation to the general application of an activated carbon process. Operating costs can be substantially reduced by pretreatment.

Air Stripping - Air stripping is a process by which volatile compounds in water are transferred to the gas phase. Air stripping is usually accomplished in a tower which blows air through the waste stream. Volatile organics such as chlorinated hydrocarbons and aromatics with a Henry's Law constant greater than $0.003\text{-atm}\cdot\text{m}^3/\text{mole}$ can generally be removed effectively by air stripping. The organic substances in the groundwater at the HCC site (methylene chloride, ethylbenzene, tetrachloroethylene, xylenes and toluene) are amenable to removal by air stripping. Air stripping is generally not suitable for soluble organics such as ketones. Air stripping can generally remove VOCs up to a concentration of approximately 100 ppm and steam stripping and distillation would be more suitable for waste streams with VOC concentrations greater than 100 ppm.

An important factor in evaluating the feasibility of air stripping to remove volatile contaminants is the possible requirement for air pollution control equipment and air emission permits.

Steam Stripping - Steam stripping is a unit process that uses steam to extract organic contaminants from a liquid or slurry. Direct injection of steam and multiple pass heat exchangers are the two most common methods. Steam stripping by injecting steam into a tray or packed distillation column is used to remove volatile organic chemicals from waste streams. This unit operation is most effectively applied to aqueous solutions to remove volatile components that are immiscible in water.

Steam stripping is commonly employed to separate halogenated and certain aromatic compounds from water. It is less effective in removing miscible organics such as ketones or alcohols. It is more economical and effective than air stripping for treating wastes with high concentrations of volatiles and low volatility. It is generally capable of treating wastes with organic concentrations ranging from less than 100 ppm to about 10% and boiling points less than 150°C. Steam stripping is retained for further evaluation.

Distillation - Distillation is a unit process which involves heating a liquid solution and condensing the vapor to separate volatiles. The separation of volatiles is based on the differences in vapor pressure exhibited by different materials at various temperatures. The residuals are still bottoms and intermediate distillate cuts. This industrial process technology is not widely used to treat wastes because it is energy and capital intensive, expensive, requires skilled operating personnel, and is limited to relatively "clean" wastes. Since HCC has experience in distillation, this technology is retained for further consideration and may be applicable if the groundwater is "clean".

Ultraviolet (UV) Photolysis/Ozonation - Ultraviolet photolysis (UV) destroys or detoxifies hazardous chemicals in aqueous solutions

utilizing UV irradiation. Adsorption of energy in the UV spectrum facilitates the oxidation of the molecule. Ozonation has been combined with UV photolysis to enhance the efficiency and rate of oxidation reactions for difficult to oxidize compounds such as halogenated organics.

Ozone dosage rates generally range from 1.5 to 3.0 lbs. per lb of contaminant. UV power requirements range 4 to 40 watts per gallon of reactor volume. UV/Ozonation is typically used to treat waste streams containing less than 1 percent oxidizable material. Because ozone is not a selective oxidizer, the presence of oxidizable materials other than target pollutants will increase the cost of the treatment.

Commercial UV/Ozonation systems are available, however these systems are not widely used. A 40,000 gpd unit requires approximately a 4,000 gallon reactor tank and 25 kW of UV light. The unit includes an ozone generator because ozone decomposes rapidly and must be generated on-site of treatment. Ultrox has manufactured two units that employ UV photolysis, ozone and hydrogen peroxide to treat an aqueous waste stream containing 0.5% of hydrazine and dimethylnitrosamine. Each unit has the capacity to treat 1800 gpd.

The UV/Ozonation process is a developing technology not in widespread use at this time and it is eliminated from further consideration.

Disposal of Groundwater - Groundwater collected at HCC can be discharged to the local tributary on site, to the POTW or transported off-site for disposal. Each of the options may necessitate pretreatment and the implementability of these options would depend on the level of pretreatment required.

2.6 Technology Screening Summary

A summary of rejected technologies, the basis for rejection and a summary of surviving technologies applicable to the HCC site is presented in Table 2.

TABLE 2

SCREENING OF REMEDIAL TECHNOLOGIES

<u>ELIMINATED TECHNOLOGIES</u>	<u>SELECT-REJECT CRITERIA⁽¹⁾</u>
<u>Groundwater Controls</u>	
Horizontal and Vertical Barriers	a,b
Groundwater Collection - Trenches	b
<u>Soil Treatment</u>	
Total Excavation	b
Soil Flushing	b,c
Soil Vapor Extraction	b
Bioreclamation	a,b
Radio Frequency Heating	a
Vitrification	a
Solidification	a
Incineration (on-site)	d
Thermal Extraction	a
<u>Groundwater Treatment</u>	
UV Photolysis/Ozonation	a
Bioreclamation	a,b
<u>APPLICABLE TECHNOLOGIES</u>	
<u>Leachate & Groundwater Controls</u>	
Capping	
Revegetation	
Groundwater Collection - Recovery Wells	
<u>Groundwater Treatment</u>	
Carbon Adsorption	
Air Stripping	
Steam Stripping	
Distillation	
<u>Soil Treatment</u>	
Partial Excavation and Off-Site Disposal	
Incineration (off-site)	

NOTES:

1. Select-reject criteria explained on page 5.

Technologies to control leachate generation and groundwater contamination and that are retained for further study include capping, selected excavation with off-site disposal and/or treatment, and groundwater collection. Treatment technologies for groundwater include carbon adsorption, air stripping, steam stripping and distillation.

3.0 ANALYSIS OF CORRECTIVE ACTION ALTERNATIVES

Corrective action alternatives for the HCC site were developed from those technologies and/or combinations of technologies which survived the technology screening. The surviving alternatives are presented, analyzed and compared in this section based on non-cost and cost criteria. The non-cost criteria consist of:

1. Environmental and Public Health Impacts; and
2. Technical Feasibility
 - a. Performance
 - b. Reliability
 - c. Implementability
 - d. Safety

The cost criteria include the capital costs and the present worth values of the annual operation and maintenance costs.

The alternatives are summarized as follows:

Alternative 1 - No Action

Alternative 2 - Capping and Plume Management

Alternative 3 - Partial Excavation, Off-site Treatment and/or Disposal, Capping and Plume Management

Alternative 4 - Capping, Pumping and Treating Groundwater including Perched Water

Alternative 5 - Capping, Pumping and Treating Perched Water and Plume Management

3.1 Non-Cost Criteria

ALTERNATIVE 1: NO ACTION

Environmental and Public Health Evaluation

Under a "no action" alternative, existing conditions would continue. This alternative would not reduce the soil contact hazard and would have no remedial impact on the groundwater. Contaminants would continue to migrate to the groundwater which discharges to the on-site tributary. Although there is no discernible impact on the surface water quality at this time and there is no significant threat posed by the contaminants in the groundwater, continued contaminant migration from soils might impact groundwater and surface water quality in the future. With time, natural attenuation would reduce contaminant concentrations. The alternative is rejected.

ALTERNATIVE 2: CAPPING CLOSURE AND PLUME MANAGEMENT

Alternative 2 consists of:

1. Placing a single layer asphalt or concrete cap over the unpaved area around the NFLCS area.
2. Filling the existing sumps in solvent tank farm with concrete.
3. Closing the tank farm pursuant to RCRA requirements 40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97 including a concrete cap over the base of the tank farm with a bearing capacity sufficient to support storage tanks.
4. Closing the cistern to satisfy RCRA closure requirements (40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97), by backfilling the tank with clean soil, sealing the access manways with concrete and repairing cracks in the concrete pavement in the cistern area.

5. Continuing the operation of the french drain system located east of the solvent tank farm remove and disposing of contaminated perched water.

Alternative 2 eliminates the continued leaching of VOCs from the soil to groundwater due to surface infiltration and the possibility of contacting exposed soil in the capped areas. The cap would also minimize the generation of perched water at the tank farm and existing perched water around the tank farm would be collected in the french drain. This perched water would continue to be transferred to one of the HCC permitted storage tanks and disposed of as hazardous waste. Perched water is the source of contaminants found in the HCC outfall and minimizing the generation of perched water will reduce infiltration into the storm water collection system. This alternative would not remove existing perched water which could continue to migrate to the storm water collection system.

Groundwater at the site discharges to the Tinker's Creek tributary, however there is no discernible impact on surface water quality. Groundwater downgradient of any contamination source(s) on HCC property to the discharge point is not used for any purpose and HCC owns and controls the property between the source and the discharge. Moreover, the yield of the formation which contains the contaminated groundwater is not sufficient to qualify it as a usable aquifer, even in the absence of VOC contamination. Alternative 2 would allow the continued discharge of untreated groundwater to the Tinker's Creek tributary pursuant to a RCRA Alternate Concentration Limit (ACL) discharge where human contact with groundwater would be effectively prevented through institutional controls. The use of an ACL in this manner is wholly consistent with Federal and State Regulations (40 CFR Part 264.94 and OAC 3745-54-94) and USEPA "Alternate Concentration Limit Guidance, Part 1, ACL Policy and Information Requirements", Document No. EPA/530-SW-87-017. The actual ACLs would be established through a Post-Closure Permit application pursuant to 40 CFR 265.197(b) and 270.1(c) and would be selected to ensure that surface water quality is not adversely impacted.

Technical Feasibility

Performance - The asphaltic and concrete caps would eliminate the possibility of contact with impacted soil and would eliminate the generation of additional leachate due to surface water infiltration. Periodic maintenance of this cap would be easily implementable and would ensure the longest practical useful lifetime and effectiveness. The cap provides a long-term, permanent and effective corrective action.

Reliability - Capping is a reliable technique to isolate material from contact and to limit continued leaching from rain water percolation. A long-term cap maintenance program would be developed to include periodic inspections and necessary repairs. This maintenance would be relatively straightforward and could be performed with readily available labor and materials. The groundwater and storm water outfall monitoring programs developed during the design phase would monitor the system effectiveness and would be sufficient to detect changes in groundwater and storm water flow and quality so that appropriate actions could be taken. Wells installed during the site investigation would be used in the groundwater monitoring program with sampling done by qualified HCC personnel on a schedule established during the design phase.

Implementability - An effective single layer asphalt or concrete cap could be placed quickly and without technical difficulty using readily available equipment, labor and materials. The thickness of this cap would be determined during the design phase based on anticipated use and load conditions. The monitoring wells are in place and the monitoring program could be implemented immediately.

Safety - During construction, unprotected workers would be exposed to contaminated soil. Unprotected workers would be exposed to contaminated groundwater and surface during sampling activities. A Health and Safety Plan (HASP) would establish the specific requirements for personal protective equipment. The HASP would be

implemented by a Health and Safety Officer and would dictate levels of protection based on the results of air quality monitoring during construction and sampling operations.

The HASP will also present a contingency plan and a list of emergency contacts including the local hospital, fire department, police department and OEPA. All workers would be advised of potential fire, explosion and chemical hazards at the site and would implement construction activities in a manner which minimizes hazards to on-site personnel and the surrounding community.

Environmental and Public Health Evaluation

Closing the tank farm and cistern and capping the NFLCS areas effectively eliminates the possibility of contacting exposed soil in the capped areas. The cap would also eliminate rainwater percolation and leaching and the generation of perched water which impacts groundwater and the storm water collection system at the site. The french drain would continue to collect existing contaminated perched water at the tank farm and control its migration. The environmental assessment indicated that, even in the absence of a cap, there were no discernible surface water quality impacts from the groundwater discharge, whether caused by percolation or by soil in contact with groundwater. In the absence of any discernible impact, a groundwater and soil VOC recovery program cannot be justified because it will not provide increased public health or environmental benefits.

ALTERNATIVE 3: PARTIAL EXCAVATION, OFF-SITE TREATMENT AND/OR DISPOSAL, CAPPING CLOSURE AND PLUME MANAGEMENT

This alternative would implement Alternative 2 supplemented by partial soil excavation in the solvent tank farm, cistern and NFLCS area.

Technical Feasibility

All components in this alternative are technically feasible and within the capacity of current techniques. However, a portion of the area to be excavated is adjacent to and under HCC buildings and structures and this would present significant geotechnical and structural problems in implementation. Partial excavation in selected areas in the solvent tank farm, NFLCS area and at the underground cistern were evaluated in lieu of general soil removal.

Limits on the location and depth of excavation were established for the tank farm and cistern area based on safety considerations relating to potential undermining at facility structures and the need for extensive shoring. Safe excavation depths established for the tank farm and cistern were five feet and three feet, respectively. The total volume of soil excavation corresponding to this depth is approximately 2400 cu yd. The approximate average total VOC concentrations were calculated for the volume of soil excavated above these depths and for soils remaining in each of these areas. The upper five feet of soils in the tank farm contain an average of 15 mg/kg of VOCs or less than 15% of concentration in the underlying soil (5 feet to 17 feet deep) which contain an average of 95 mg/kg VOCs. Based on these concentrations, the total approximate mass of VOCs in the upper five feet of soil is 45 kg and in underlying soils, which would remain after excavation is 680 kg. Soils at the underground cistern have an average VOC concentration of 2200 mg/kg in the upper three feet and an approximate average of 500 mg/kg between 3 to 14.5 feet. Excavating the upper three feet of soil would remove the greatest concentration of contaminated soils, however the backfilled soil would be contaminated as existing perched water in the vicinity of the plant migrates toward the cistern.

The highest concentrations of VOCs (2329 mg/kg) were found in soil taken from Boring SB-46 (4.0-6.5 feet) at the NFLCS area. Soil excavation in this area would not be feasible to this general depth due to the steep sloping grade to the east of the area.

Considering the excavation problem and the fact that greater than 90% of this contamination would remain on-site and that off-site soil disposal in a RCRA landfill would probably require incineration, partial excavation provides no material benefit over and above capping. Considering the safety problem, it is the less desirable alternative.

Performance - Capping with asphalt and concrete prevents contact with the soil and eliminates infiltration. Partial or selective excavation would minimize the possibility of contacting the contaminated materials but would provide no significant incremental public health or environmental protection benefit because only a small percentage of contaminants could be removed. The off-site disposal of excavated soil in a RCRA landfill with pretreatment by incineration would also subject the public to significant future risk. The cap would require a long-term maintenance program which would be easily implemented and would ensure that its integrity is maintained. Plume management and collection of perched water in the french drain would perform effectively as discussed in Alternative 2.

Reliability - Capping is a reliable technique to isolate material from contact and it virtually eliminates leaching due to percolation. Excavation and off-site disposal implies a one-time cost rather than recurring costs through time. However, disposal of excavated material from the HCC site would have to meet Land Disposal Restrictions as of November 8, 1990 and would probably require pretreatment by incineration prior to being placed in an off-site RCRA landfill which may become a future compliance problem. The on-site cap is the more reliable alternative because HCC can control the inspection and maintenance program. The reliability of plume management and collection of perched water in the french drain is discussed in Alternative 2.

Implementability - The excavation of shallow soils in the tank farm and cistern area and all components of this alternative can be implemented in a straightforward and timely manner. Excavation in

areas partially under and adjacent to the HCC processing building would not be possible without extensive shoring, precise backfilling and possibly geotechnical stabilization to prevent structural damage and minimize production downtime. The plume management program could be implemented immediately as discussed in Alternative 2 and french drain collection system is already in place.

Safety - A HASP would be implemented by the Safety Officer and would specify the requisite level of personal protection required during construction and sampling operations. The HASP would specify a Contingency Plan and levels of personal protective equipment based on air quality monitoring conducted during excavation and capping activities.

The approximate volume of excavated soil would be 2400 cu yd and off-site treatment and disposal would present safety hazards associated with transporting approximately 120 truck loads of soil. The excavation component will require a specific safety protocol entailing the use of personal protection equipment and construction procedures to ensure safe conditions in open excavations adjacent to supported/non-supported structures. The excavation component implies safety hazards far beyond the merit of the alternative.

Environmental and Public Health Evaluation

The alternative provides environmental and public health benefits associated with capping site areas to eliminate contact and leaching. The soil excavation component offers no net advantage over the cap because over 90% of the contaminant mass is found in soils at depths below practical excavation limits and under buildings and structures where excavation is not feasible. The environmental and public health benefits of plume management and continuing collection of perched water at the french drain are discussed in Alternative 2. All environmental and public health benefits are achieved by capping, plume management and continuing collection of perched water at the french drain without the need for an excavation component that can only be implemented with significant risk.

ALTERNATIVE 4: CAPPING CLOSURE, PUMPING AND TREATING GROUNDWATER
INCLUDING PERCHED WATER

Alternative 4 confers the same benefits and implies the same risks as Alternative 2, capping, closing the cistern and tank farm and continuing operation of the french drain with the addition of a groundwater pumping and treatment option which would collect additional perched water near the underground cistern and downgradient of the tank farm. Alternative 4 achieves the public health and environmental protection objectives of the corrective action program by eliminating leaching and soil contact and it would contain the groundwater plume and collect perched groundwater. A collection and pumping system would be installed near the cistern where perched water accumulates. This perched water impacts the quality of the storm water discharge at the site.

A large diameter extraction well or a number of small diameter wells would be installed to recover groundwater downgradient of the tank farm. A capture zone would be established by conventional pumping and the recovered groundwater would be treated on- or off-site. This corrective action study has found that distillation, air stripping, steam stripping and carbon adsorption may be applicable and these technologies would be evaluated further in the corrective action study design phase through bench scale treatability testing.

Technical Feasibility

Performance - The anticipated performance of the cap and of the french drain is the same as Alternative 2. Recovery wells are an effective plume containment method, however, regardless of the number of wells or their method of operation, the anticipated yield in weathered shale would be very low and the short and long-term effectiveness of any groundwater recovery or control system would be limited by this site characteristic. The anticipated useful life of the recovery wells would be short as the presence of silt in groundwater at the site would foul the well screens.

The collection and pumping system near the cistern would remove accumulated perched water at the east side of the process building and the french drain would continue to collect existing perched water east of the tank farm. These systems should minimize the infiltration of contaminated perched water to the storm water piping in these areas.

Steam stripping, distillation and carbon adsorption have been identified as viable treatment technologies either individually or in combination and the anticipated useful lifetimes of these technologies would be approximately 25 to 30 years with proper operation and maintenance. At that time, replacement may be necessary. The performance of this alternative would be evaluated through a groundwater and storm water monitoring program established during the corrective action design phase. Perched water flow and contaminant concentrations should decrease over time since the tank farm and cistern would be capped. Based on monitoring results, it may be necessary to install additional containment, collection or diversions for perched water at other site locations.

Reliability - The reliability of the cap and the french drain is the same as Alternative 2. The operation of the recovery system would be straightforward and could be performed by HCC personnel. Well maintenance would be necessary to minimize loss of services from silting and this as well as pump maintenance and replacement would be performed by contractors. Of the treatment technologies being evaluated, carbon adsorption and air stripping are the least complex and require the least maintenance. Steam stripping and distillation, would require skilled personnel and a more intensive maintenance program and would be less reliable.

Implementability - The cap as discussed in Alternative 2 is readily implementable. The pumping systems are implementable but significantly constrained by the physical limitation of recovering groundwater in the weathered shale and perched water in fill at the site. It would be necessary to conduct a controlled pumping test during the design phase to identify the characteristics of a

groundwater removal system including number of wells, locations, pumping/purging requirements and achievable long-term yield. The efficiency of the groundwater treatment system would be effectively controlled by the capacity of the removal system and could only be established after an evaluation of pumping test data and treatability studies. The treatment systems, air stripping, steam stripping, carbon adsorption and distillation would require approximately 1-1/2 to 2 years to design, construct, start-up and shake-down. Additional time may be required to obtain effluent discharge, air emission and hazardous waste treatment permits.

Environmental and Public Health Evaluation - The cap and french drain presented in this alternative provide the same benefits as Alternative 2 and eliminate contact with soil and leachate generation. Groundwater at the site discharges to the on-site tributary and there are no discernible impacts on surface water. The groundwater is not used for any purpose and low yield limits its future use even in the absence of contamination. The plume does not cause any significant adverse environmental or public health impacts.

Recovery and treatment could cause adverse impacts including air emissions from the treatment processes and the potential for contaminant releases from either the disposal or regeneration of spent carbon.

Safety - The safety considerations implied by the capping presented in this alternative are the same as Alternative 2 and would be mitigated via the HASP. This HASP would also address hazards associated with installation of recovery wells and construction start-up and operation of the treatment system. The treatment system would be operated by trained HCC personnel and would present only a marginal increased risk over HCC's present solvent recycling activities.

ALTERNATIVE 5: CAPPING, CLOSURE, CONTINUING OPERATION OF THE
FRENCH DRAIN, PUMPING AND TREATING PERCHED GROUNDWATER
AND PLUME MANAGEMENT

Alternative 5 includes corrective actions identified in Alternative 2 (Capping, Closure and Plume Management) with the addition of a perched water collection system and in summary consists of:

1. Placing a single layer asphalt or concrete cap over the unpaved area around the NFLCS area.
2. Filling the existing sumps in the solvent tank farm with concrete.
3. Closing the tank farm pursuant to RCRA requirements 40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97 including a concrete cap over the base of the tank farm with a bearing capacity sufficient to support storage tanks.
4. Closing the cistern to satisfy RCRA requirements (40 CFR 265.111, 265.197, OAC 3745-66-11 and OAC 3745-66-97), by backfilling the tank with clean soil, sealing the access manways with concrete and repairing cracks in the concrete pavement in the cistern area.
5. Continuing operation of the french drain system located east of the solvent tank farm, removing and disposing of contaminated perched water.
6. Installing a perched water collection system near the cistern.
7. Plume management.

This alternative satisfies the public health and environmental protection objectives of the corrective action program by eliminating

leaching and exposure to soils and would remove a portion of the perched water. A collection and pumping system would be installed near the cistern where perched water accumulates. The perched water appears to be the source of contaminants found in the storm water outfall. This perched water apparently infiltrates the underground storm water piping. This alternative would minimize the generation of perched water through cistern and tank farm closure via capping and the collection system would remove the perched water. The collected water would be treated on or off-site. Potential treatment options are air stripping, steam stripping, distillation and carbon adsorption. The options would be evaluated in the design phase of this study through bench scale testing.

This alternative would allow the continued discharge of groundwater downgradient of the tank farm to the on-site tributary pursuant to a RCRA ACL which would be consistent with 40 CFR Part 264.94 and OAC 3745-54-94. As requested by USEPA in a December 8, 1989 letter, this alternative includes, as a contingent corrective action, the pump and treat system for groundwater downgradient of the tank farm evaluated in Alternative 4.

Performance - The performance of this alternative would be similar to Alternative 4 (Capping, Closure, Pumping and Treating Groundwater Including Perched Water) and the useful life of these corrective measures would be contingent on the operation and maintenance program developed to ensure the integrity of the cap and the operation of the pumping and treatment systems. The expected useful life of the treatment system would be 25-30 years at which time replacement may be necessary. The performance of this alternative would be evaluated through a groundwater and storm water collection system monitoring program established during the corrective action design phase to ensure that surface water is not impacted. Perched water flow and contaminant concentrations should decrease over time since the sources of perched water (tank farm and cistern) would be capped. Based on monitoring results, it may be necessary to install additional containment, collection or diversions for perched water at other site locations.

Reliability - The reliability of the cap and french drain system would be the same as Alternative 2. The operation of the recovery system would be straightforward and could be performed by HCC personnel. Air stripping, steam stripping and distillation would require skilled HCC operating personnel and would be less reliable than carbon adsorption. The groundwater and storm water monitoring systems would reliably detect changes in groundwater quality necessary to ensure that surface water is not impacted.

Implementability - The [perched water collection and] pumping system near the cistern could be readily installed, however, it would be necessary to conduct pumping tests during the corrective action design phase to identify the anticipated yield and the appropriate pumping rates. The pumping test data would be utilized in a treatability study during the design phase to determine the most cost-effective method to treat and dispose of collected perched water. On-site treatment technologies including steam stripping, distillation and carbon adsorption have been retained for further evaluation, however off-site disposal at a TSD facility as an alternative to on-site treatment would be evaluated in the design phase.

The cap could be designed and constructed within 6-12 months. The treatment systems, steam stripping, carbon adsorption and distillation could require approximately 1-1/2 to 2 years to design, construct, start-up and shake-down. Additional time may be required to obtain effluent discharge, air emission and hazardous waste treatment permits. The monitoring system is in place and can be implemented immediately.

Environmental and Public Health Evaluation - The environmental benefits provided by this alternative are similar to Alternative 2 (Capping, Closure and Plume Management). The cap would eliminate the leaching of contaminants from soils to groundwater due to surface infiltration and the possibility of contacting exposed soil in capped areas. The cap would also minimize the generation of perched water around the tank farm. Existing perched water around the tank farm

would be collected in the french drain, transferred to HCC's permitted storage tanks and disposed of as hazardous waste. This alternative would eliminate the infiltration of perched water and the migration of perched water to the storm water collection system at the east side of the HCC processing building. The discharge of groundwater downgradient of the tank farm to the on-site tributary pursuant to a RCRA Alternate Concentration Limit which would be established pursuant to a Post-Closure Permit application as required by 40 CFR 265.197(b) and 270.1(c). The ACL would be developed in accord with RCRA 264.94 regulations and USEPA ACL guidance documents to ensure that surface water quality is not adversely impacted.

Safety - Unprotected workers would be exposed to contaminated soil during construction of the cap and to contaminated groundwater during sampling and pumping activities. A HASP would require that workers wear personal protection equipment during construction and sampling operations. This plan would present levels of protection based on air quality monitoring and health and safety practices for installation, operation and maintenance of the cistern pumping and treatment system.

3.2 Cost Criteria

This section presents the estimated capital and annual operation and maintenance costs for each alternative. The present worth values of the capitalized annual costs are also presented and these costs are calculated at a 10% interest rate for a 30 year period. Closure costs for the tank farm and cistern are presented in detail in the January 1990 Closure Plan for these units and are included in this report as a lump sum cost. The Closure Plan includes contingency and engineering costs.

ALTERNATIVE 1: NO ACTION

The estimated annual operation and maintenance (AOM) for Alternative 1 is \$24,000 (Table 3). There are no capital costs associated with this alternative. The present worth value of AOM cost is \$226,000.

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TABLE 3

ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATE
ALTERNATIVE 1

<u>Item and Description</u>	<u>Cost</u>
1. Groundwater and Surface Water Sampling ⁽¹⁾	\$ 3,000
2. Laboratory Analyses	<u>16,000</u>
3. SUBTOTAL	\$19,000
4. Contingencies & Engineering @ 25%	<u>5,000</u>
5. TOTAL	\$24,000

NOTES:

1. By trained HCC personnel.

ALTERNATIVE 2: CAPPING, CLOSURE AND PLUME MANAGEMENT

Alternative 2 consists of plume management, closing the solvent tank farm and cistern, capping the NFLCS area and continuing operation of the french drain at the solvent tank farm.

The estimated capital cost for this alternative is \$308,000 and is presented in Table 4. The AOM requirements consist of groundwater and surface water monitoring; and inspection and maintenance of the concrete and asphalt caps. The AOM cost is estimated to be \$26,000 and is presented in Table 5. The present worth value of this cost is \$245,000.

ALTERNATIVE 3: PARTIAL EXCAVATION, CLOSURE, OFF-SITE TREATMENT AND/OR DISPOSAL, CAPPING AND PLUME MANAGEMENT

Alternative 3 consists of capping, plume management and excavating the upper five feet of soil in the solvent storage tank farm and the upper three feet of soil around the cistern, closing the cistern and tank farm, continuing operation of the french drain and capping the NFLCS area. The estimated capital cost for this alternative is \$1,268,000. The breakdown of this cost estimate is presented in Table 6. The AOM requirements and costs are the same as Alternative 2.

ALTERNATIVE 4: CAPPING, CLOSURE, PUMPING AND TREATING GROUNDWATER INCLUDING PERCHED WATER

This alternative consists of capping the NFLCS area, closing the solvent storage tank farm and cistern, installing a groundwater recovery system (including perched water recovery) and the required pumping tests. Capital costs are presented in Table 7 and the total cost of the alternative is estimated to be \$785,000 based on installing an on-site treatment system consisting of a combination of steam stripping or distillation and activated carbon. The number of recovery wells would be determined during the design phase of this

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TABLE 4

CAPITAL COST ESTIMATE
ALTERNATIVE 2

<u>Item and Description</u>	<u>Cost</u>
1. Cap the Area Around the No-Free Liquid Container Storage	\$ 3,000
2. Contingencies & Engineering	1,000
3. Cistern and Tank Farm Closure	<u>304,000</u>
4. TOTAL	\$308,000

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TABLE 5

ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATE
ALTERNATIVE 2

<u>Item and Description</u>	<u>Cost</u>
1. Groundwater and Surface Water Sampling ⁽¹⁾	\$ 3,000
2. Laboratory Analyses	16,000
3. Cap Inspection and Maintenance	<u>2,000</u>
4. SUBTOTAL	\$21,000
5. Contingencies & Engineering @ 25%	<u>5,000</u>
6. TOTAL	\$26,000

NOTES:

1. By trained HCC personnel.

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TABLE 6

CAPITAL COST ESTIMATE
ALTERNATIVE 3

<u>Item and Description</u>	<u>Cost</u>
1. Soil Excavation at the Solvent Tank Farm, Cistern and No-Free Liquid Container Storage Area	\$ 24,000
2. Soil Disposal (including transportation) ⁽¹⁾	720,000
3. Backfill and Grade	24,000
4. Install the Asphalt Cap Around the No-Free Liquid Container Storage Area	<u>3,000</u>
5. SUBTOTAL	\$ 771,000
6. Contingencies & Engineering @ 25%	193,000
7. [Cistern and Tank Farm Closure]	<u>304,000</u>
8. TOTAL	\$1,268,000

NOTES:

1. The approximate volume of soil is 2400 yd³.

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TABLE 7

CAPITAL COST ESTIMATE
ALTERNATIVE 4

<u>Item and Description</u>	<u>Cost</u>
1. Install the Asphalt Cap at the No-Free Liquid Container Storage Area	\$ 3,000
2. Install the Perched Water Collection and Pumping System Near the Cistern and Conduct Pumping Tests	12,000
3. Install Wells For Pump Tests and Recovery Wells	100,000
4. Conduct Bench Scale Treatability Studies	20,000
5. Install On-Site Treatment System ⁽¹⁾	<u>250,000</u>
6. SUBTOTAL	\$385,000
7. Contingencies & Engineering @ 25%	96,000
8. Cistern and Tank Farm Closure	<u>304,000</u>
9. TOTAL	<u>\$785,000</u>

NOTES:

- Results of the Bench Scale Treatability Study would be used to reevaluate the treatment cost. This estimate is based on the need for the combination of steam stripping or distillation and carbon adsorption technologies.

project. This cost estimate is based on installing four wells. The AOM costs are estimated to be \$220,000 as shown in Table 8. The present worth value of the AOM cost is \$2,074,000.

Once the pumping test and treatability study results are reviewed, this alternative would be evaluated further and refined cost estimates would be developed.

ALTERNATIVE 5: CAPPING, CLOSURE, CONTINUING OPERATION OF THE
FRENCH DRAIN, PUMPING AND TREATING PERCHED GROUNDWATER
AND PLUME MANAGEMENT

Alternative 5 consists of closing the solvent tank farm and cistern, capping the NFLCS area, recovering perched water near the cistern and plume management. This alternative includes a contingent pump and treat corrective action for groundwater downgradient of the tank farm.

The estimated capital cost for this alternative is \$660,000. This estimate is presented in Table 9 and is based on the need to install on-site steam stripping and carbon adsorption systems to treat the types and concentrations of organics found in perched water at HCC. The estimated AOM costs is \$120,000 as shown in Table 10. The present worth value of the AOM cost is \$1,130,000. This alternative and the capital costs would be further evaluated once the pumping test and treatability study results are reviewed. The AOM requirements and costs would be developed at that time.

Comparison of Alternatives

This section compares the alternatives in terms of performance, reliability, implementability, safety and cost. Many of the alternatives in each category provide similar outcomes or are only marginally different and only the salient differences are compared in this section. The numbers in parenthesis refer to the alternatives listed in the following summary:

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TABLE 8

ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATE
ALTERNATIVE 4

<u>Item and Description</u>	<u>Cost</u>
1. Groundwater and Surface Water Sampling ⁽¹⁾	\$ 3,000
2. Laboratory Analyses	16,000
3. Cap Inspection and Maintenance	2,000
4. Treatment System Operator	27,000
5. Equipment Maintenance	35,000
6. Utilities	20,000
7. Carbon Replacement (Quarterly)	<u>80,000</u>
8. SUBTOTAL	\$183,000
9. Administration @ 20%	<u>37,000</u>
10. TOTAL	\$220,000

NOTES:

1. By trained HCC personnel.

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TABLE 9

CAPITAL COST ESTIMATE
ALTERNATIVE 5

<u>Item and Description</u>	<u>Cost</u>
1. Install the Asphalt Cap at the No-Free Liquid Container Storage	\$ 3,000
2. Install the Perched Water Collection and Pumping System Near the Cistern and Conduct Pumping Tests	12,000
3. Conduct Bench Scale Treatability Studies	20,000
4. Install On-Site Treatment System ⁽¹⁾	<u>250,000</u>
5. SUBTOTAL	\$285,000
6. Contingencies & Engineering @ 25%	71,000
7. Cistern and Tank Farm Closure	<u>304,000</u>
8. TOTAL	<u>\$660,000</u>

NOTES:

- Results of the Bench Scale Treatability Study would be used to re-evaluate the treatment cost. This estimate is based on a combination of steam stripping or distillation and carbon adsorption technologies.

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TABLE 10

ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATE
ALTERNATIVE 5

<u>Item and Description</u>	<u>Cost</u>
1. Groundwater and Surface Water Sampling ⁽¹⁾	\$ 3,000
2. Laboratory Analyses	16,000
3. Cap Inspection and Maintenance	2,000
4. Treatment System Operator	12,000
5. Equipment Maintenance	25,000
6. Utilities	10,000
7. Carbon Replacement (Quarterly)	<u>30,000</u>
8. SUBTOTAL	\$100,000
9. Administration @ 20%	<u>20,000</u>
10. TOTAL	\$120,000

NOTES:

1. By trained HCC personnel.

Alternative 2 - Capping, Closure and Plume Management

Alternative 3 - Partial Excavation, Off-Site Treatment and/or Disposal, Capping, Closure and Plume Management

Alternative 4 - Capping, Closure, Pumping and Treating Groundwater including Perched Water

Alternative 5 - Capping, Closure, Pumping and Treating Perched Water and Plume Management

Performance

Performance relates to the ability of the corrective action to provide public health and environmental benefits. To some extent all the alternatives minimize sources, generation rates and contact hazards, however, there are significant differences in the implied levels of performance.

The most significant performance differences arise as a consequence of attempting to improve on the performance of straightforward capping. All alternatives, except no action, would employ concrete or asphaltic caps to minimize the generation infiltration and leaching of perched water, to eliminate soil contact hazards and as a source control measure. The long-term performance and effectiveness of this capping component cannot readily be improved by excavation (3) because complete excavation is not technically feasible and partial excavation implies only an insignificant benefit because of the limited removal possible at the site. A partial excavation alternative (3) would also require a cap. The cap effectively eliminates the benefit derived from the excavation alternative and there is no net improvement realized by excavation. If there is no performance benefit derived from excavation, performance issues relating to on- or off-site disposal are moot.

It is evident that contaminated perched water in the cistern area migrates into the storm water collection system. Alternative 5 responds to this problem by collecting/pumping perched water near the cistern and treating the pumpage. Although Alternative 5 may not be immediately implementable because it may be necessary to obtain discharge permits and the system would have to be designed based on pilot studies, it is the only corrective action that implies a reasonable level of performance in dealing with the perched water. The performance benefits derived from controlling the perched water can be said to outweigh the implementation problem.

The performance requirement is not as evident in the case of the groundwater plume which has no discernible surface water impact. The continued discharge of groundwater pursuant to a RCRA ACL (5) provides adequate performance because there is no evident impact that would require increased performance. The ACL effectively provides performance equivalent to the groundwater pump and treat alternative (4) because there is no discernible impact and no relevant time horizon. Alternative 5 includes a contingent pump and treat corrective action described in Alternative 4 to be implemented in the event that the ACL cannot be achieved. This corrective action strategy is justified because the performance expected from the groundwater recovery option (4) is severely limited by the site conditions. Institutional controls via deed covenants and land use restrictions would assure performance through Hukill's tenure at the site and in subsequent use(s).

Implementability

Alternatives that treat groundwater on-site (4, 5) imply lengthy delays for both administrative and technical reasons (permits, field testing and construction). The off-site disposal of perched water (5) does not imply any associated implementation delay although the on-site treatment component would require permits, field trials, and construction.

All alternatives would cap certain areas to eliminate soil contact hazards and to minimize percolation. Concrete and asphaltic caps were specified for load bearing and efficiency and, except for weather conditions, these caps do not present an implementation constraint. Alternatives specifically designed to mitigate the perched water problem are implementable to the extent that percolation and infiltration to the storm water system are minimized by the cap.

Total excavation cannot be implemented without significant safety related constraints. Partial excavation with off-site disposal (3) presents no implementation problem over and above the transportation safety issue and the requirement for disposal in a RCRA landfill, with or without pretreatment. Pretreatment required by USEPA Disposal Regulations could affect the progress of the work. Although partial excavation is readily implementable, it fails in performance and provides no significant benefit because it cannot remove a sufficient mass of contaminated material to constitute a benefit and the area would have to be capped in any case.

Reliability

The reliability criteria relates to the long-term effectiveness of the alternative and anticipated maintenance and replacement.

Alternatives that rely solely on soil excavation cannot be said to be reliable in the site specific context because complete excavation is not feasible and partial excavation will fail because the fill would be recontaminated over time by contaminated perched water. The most reliable source control alternative would employ a cap and the reliability and performance implied by the cap eliminates the need to excavate soil.

Plume management pursuant to the ACL is reliable because there is no contact hazard and no discernible environmental impact. A pump and treat alternative (4) would provide similar performance but would imply administrative and technical delays in implementation and the

reliability of any pumping system in weathered shale is questionable without significant maintenance and replacement cost. The least reliable alternatives would rely on specialized equipment and operating expertise, i.e. pumping systems, treatment systems (4, 5). Alternative 5, which would pump from the cistern, implies greater reliability because of the nature of the pump and the absence of well screens and replacement costs associated with silting.

Safety

In general, all worksite safety issues would be considered in a HASP and all alternatives would be implemented in accord with the HASP. Alternatives that require total or partial excavation along building walls and under structures present significantly safety risks in implementation. The risk implied by Alternative 3 may not confer offsetting benefit since other less risky alternatives can accomplish the corrective action objectives. Alternatives that require the transportation of soil (3, 5) or water for off-site treatment or disposal present a safety related transportation risk.

Cost Comparison

A cost comparison summary is provided in Table 11.

Alternative 3 implies significant capital costs and presents a safety issue in implementation without offsetting performance or reliability benefits. Alternative 2 is the least cost alternative, but provides no environmental performance over and above the cap. Alternative 2 would not effectively control the infiltration of perched water into the storm water system and therefore it does not provide sufficient performance related benefit.

The capital cost difference between Alternatives 4 and 5 relates to the groundwater control component (wells and treatment) which provides no significant environmental or public health benefit. The operating and maintenance costs implied by Alternative 4 relate also

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TABLE 11

COST COMPARISON

	<u>Capital Cost Estimate</u>	<u>Annual Operating and Maintenance Cost Estimate (Present Worth Value)</u>
Alternative 2	\$ 308,000	245,000
Alternative 3	1,268,000	245,000
Alternative 4	785,000	2,074,000
Alternative 5	660,000	1,130,000

to the need to replace wells and maintain/operate the groundwater treatment system. This again provides no net benefit over and above Alternative 5.

Preferred Corrective Action Alternative

Alternative 5 achieves all corrective action requirements in a timely and implementable manner. Alternative 5 minimizes the generation of contaminated perched water and groundwater without the need for excavation which, at best, could remove only a small portion of the contaminated mass and which will not achieve the requisite level of performance unless the excavated and filled area is capped. Alternative 5 recognizes that there is no discernable environmental impact from the groundwater discharge and this discharge would continue under a RCRA ACL with the limits established at a level that would ensure no significant impact. The ACL is implementable without delay and is the reasonable response in the site specific context where a more costly and problematic pump and treat response would not convey additional environmental benefit.

Alternative 5 effectively eliminates the soil contact hazard while allowing the continued productive use of the site.

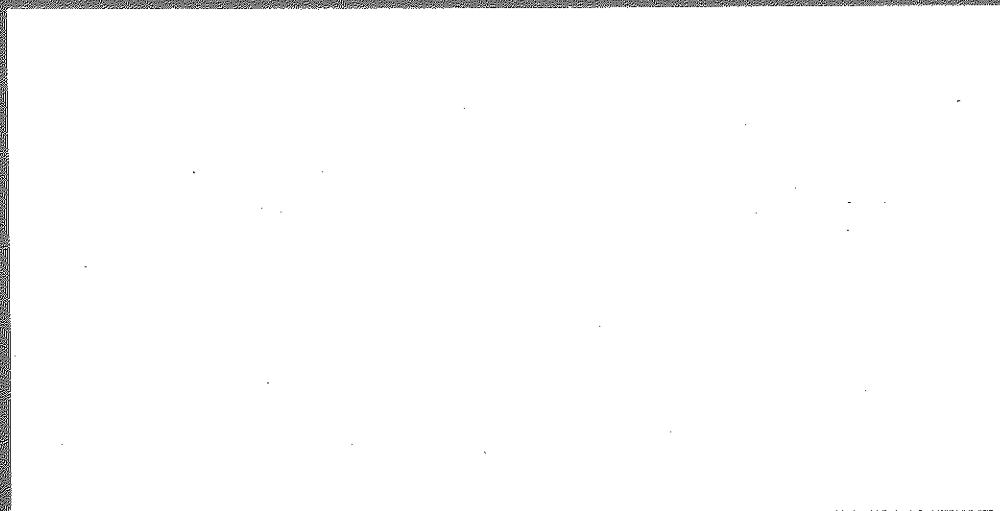
Alternative 5 includes a contingent pump and treat corrective action for groundwater downgradient of the tank farm, to be implemented in the event that the ACL is not effective.

Alternative 5 is not the lowest cost alternative, however, it eliminates redundant expenditures and provides the highest order of performance from current and long term costs.

Alternative 5 is the preferred alternative and should be implemented.

APPENDIX A

DRAWINGS



THE NATURE AND EXTENT
OF THE
OFFSITE MIGRATION OF CONTAMINANTS
AT THE
HUKILL CHEMICAL FACILITY

12-82

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1. INTRODUCTION

This study was conducted by NUS Corporation at the request of Hukill Chemical Corporation in Bedford, Ohio. The study design was presented to the United States Environmental Protection Agency (EPA), Region V, in outline form on August 12, 1982, at a meeting in their offices in Chicago. As a result of that meeting "A Plan and Implementation Schedule to Determine the Nature and Extent of Contamination That May Have Resulted from Operations at the Hukill Chemical Facility" was prepared and submitted to EPA on August 23, 1982, by NUS Corporation. This Plan was subsequently modified on September 3, at the EPA's request, to include a second set of samples and an analysis for total organic halogen. The modified Plan was approved by EPA verbally on September 2 and by letter on September 24, 1982.

2. STUDY DESIGN

The goal of the overall study is to develop an implementation plan to reduce, if necessary, the offsite transport of pollutants resulting from the operation of the facility. The study includes data collection and evaluation to determine which pollutants handled by Hukill Chemical may be leaving the site, whether Hukill Chemical's contribution can be considered significant, the remedial actions required, if any, and an evaluation of the effectiveness of any such actions.

The study was designed in two phases. This report is the result of the first phase and contains the findings of the hydrogeologic study of the site and recommendations for additional actions on the part of Hukill Chemical. Once this report has been reviewed by the EPA and the additional actions have been agreed upon, an implementation plan and schedule will be prepared and submitted to the EPA as the product of the second phase.

It is important to recognize that this study was not designed to characterize the distribution of contaminants onsite. Such a study would require more detailed sample collection and analysis over an extended period of time. Instead, this study was directed toward reducing contamination leaving the facility by evaluating the contaminants moving through the unconsolidated materials to areas off the Hukill Chemical property. This was accomplished through careful location of the sampling points so that specific sources could be identified.

Surface water quality was evaluated to determine the facility's impact on downstream water quality. The sampling sites were selected to provide the basis for examining the quality of surface water entering the site, the effect of the discharge from the outfall, and the quality of groundwater runoff to the stream. (Groundwater runoff results from precipitation that percolates downward, travels through the unconsolidated deposits, and is discharged to the stream.)

The monitoring well locations were selected to provide a wide range of information. An upgradient well was located in a manner to facilitate the deter-

mination of groundwater quality that was not influenced by facility operation and to offer representative information concerning the groundwater effects of upgradient offsite operations. Two downgradient wells were located at points designed to provide comparative data to be used in evaluating whether onsite pollutants are the result of specific units or the result of past operations in general. A fourth well was located near the buried cistern since it was anticipated that contamination resulting from that area might mask other sources of contamination.

Two sets of samples were collected from sampling points at a one month interval. It had been hoped that the two sampling periods might indicate the differences in water quality during wet and dry periods. However, both sets of samples were collected during relatively wet periods and should be considered representative of typical wet fall conditions. During the second sampling period, a grab sample was collected from the standing water in the solvent tank farm. A third sampling period was added to the overall study to further investigate the possible effect of the solvent tank farm and the outfall. The samples collected included water in standpipes used to dewater the tankfarm, the outfall, and the interceptor sewer prior to discharge to the API Separator.

3. FIELD PROCEDURES

The data collection program at the Hukill Chemical facility consisted of installing groundwater monitoring wells, surveying the well points for horizontal and vertical control, and collecting groundwater and surface-water samples for analysis. These activities were performed in accordance with the EPA-approved Plan and Implementation Schedule dated August 23 and modified September 3, 1982.

3.1 Well Installation

On September 13, 1982, a hydrogeologist from NUS sited four monitoring wells at the Hukill Chemical facility. Groundwater flow in the unconsolidated deposits was assumed to be in the direction of the onsite stream and approximately north to northeast. The location of the wells is shown on Figure 1. Well number G-1 is the upgradient well and wells number G-2 and G-3 the downgradient wells for the facility. Well number G-2 was located in the vicinity of the downgradient end of the easterly erosion channel. Well number G-3 was located downgradient from the north tank farm. Well number G-4 was located nearby and downgradient from the buried cistern. Since the site is nearly flat (surficial topography), the two most northerly downgradient wells (G-2 and G-3) were installed first to aid in more precisely locating the upgradient well (G-1).

The drill rig and operators were supplied by Triggs & Associates, Inc., a local drilling firm. A hydrogeologist from NUS logged the boreholes through visual inspection of the materials removed (see Appendix A) and supervised the installation of the monitoring wells. Both the depths of the boreholes and the construction of the monitor wells (see Table 1) were designed to reflect specific hydrogeologic conditions discovered during drilling. Permeability samples were collected for each unconsolidated unit identified.

Monitoring-well installation consisted of inserting 2-inch industrial-grade (type 304), schedule 5 (0.065-inch thick), stainless steel casing (see Figures 2 through 5) in the boreholes. All flush threaded joints were wrapped with teflon tape. Each well was screened for 10 feet with seven slot (0.007-inch)

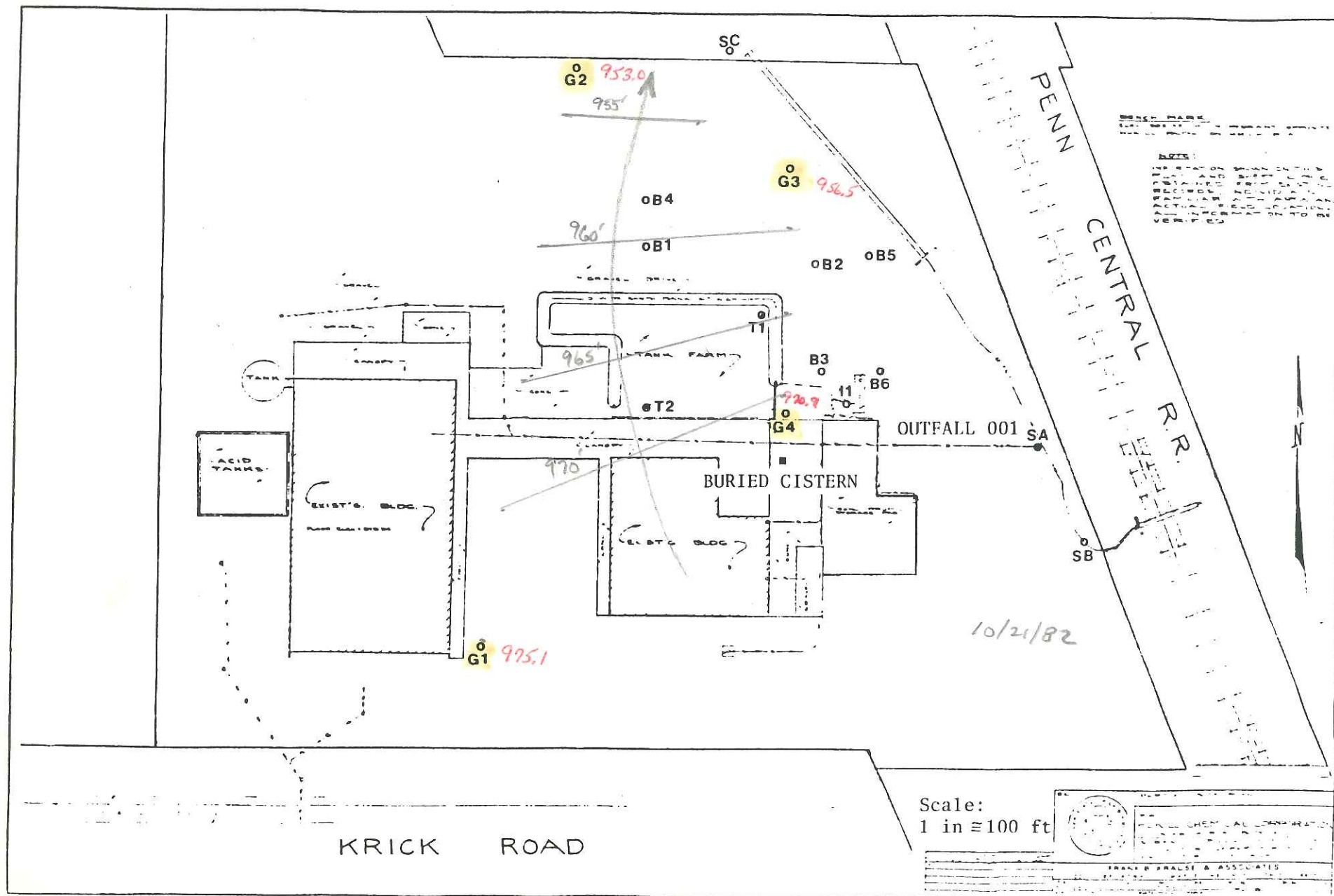


Figure 1. Location of On-site Borings and Sampling Points

Table 1. Monitor Well Construction Information

Well Number	Date Installed	Elevation Land Surface	Depth Drilled (ft)	Well Depth (ft) *	Screen Length (ft)	Standpipe Height (ft)	Elevation Top of Pipe
G-1	9/15/82	979.36	28	30.92	10	2.98	982.34
G-2	9/14/82	975.87	33	36.16	10	3.42	979.29
G-3	9/13/82	977.03	42	44.16	10	2.50	979.53
G-4	9/14/82	979.17	18	19.33	10	1.38	980.55

*From top of casing.

SCALE APPROXIMATE

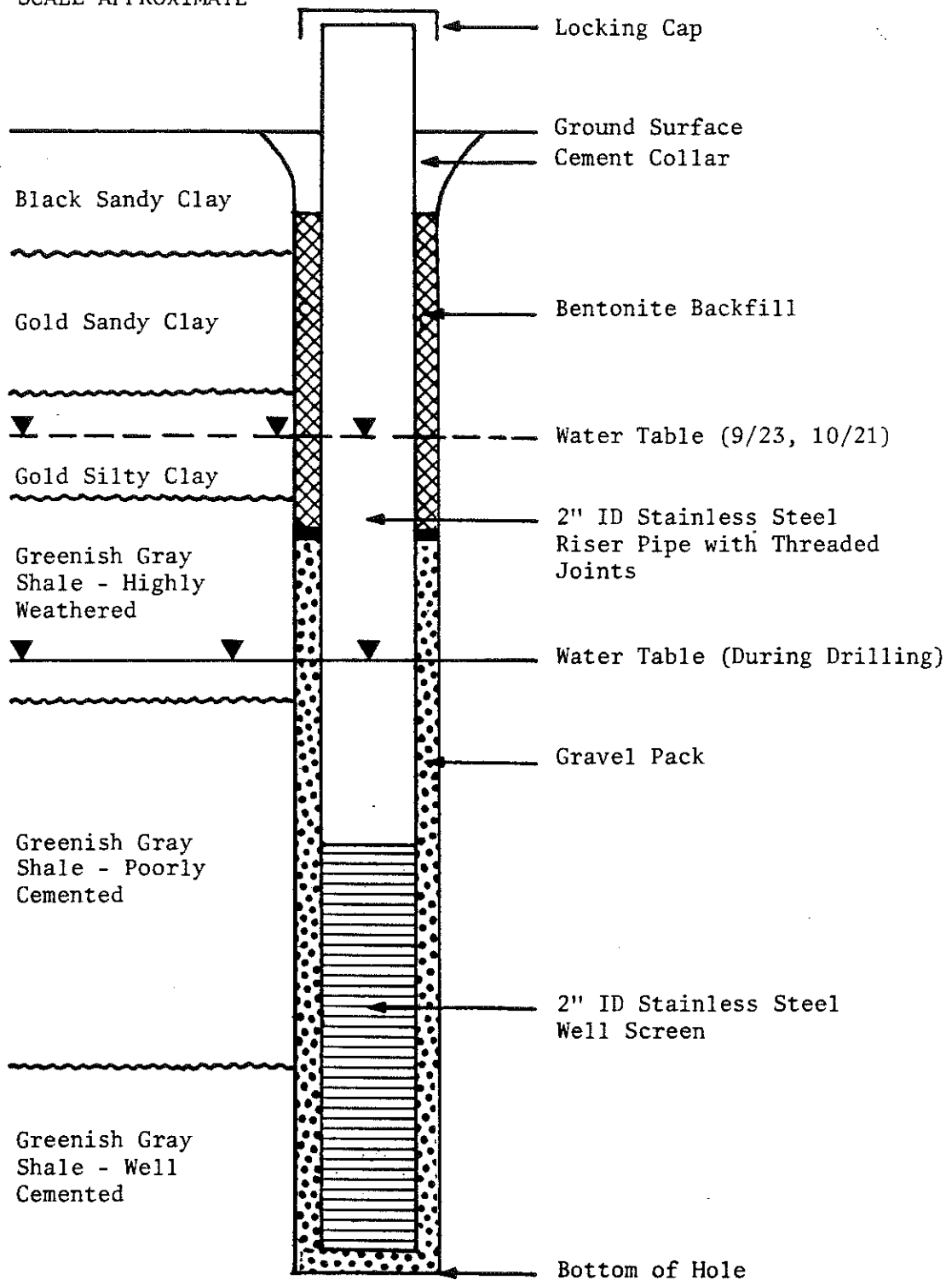


Figure 2. As-built Design of Monitor Well No. G-1

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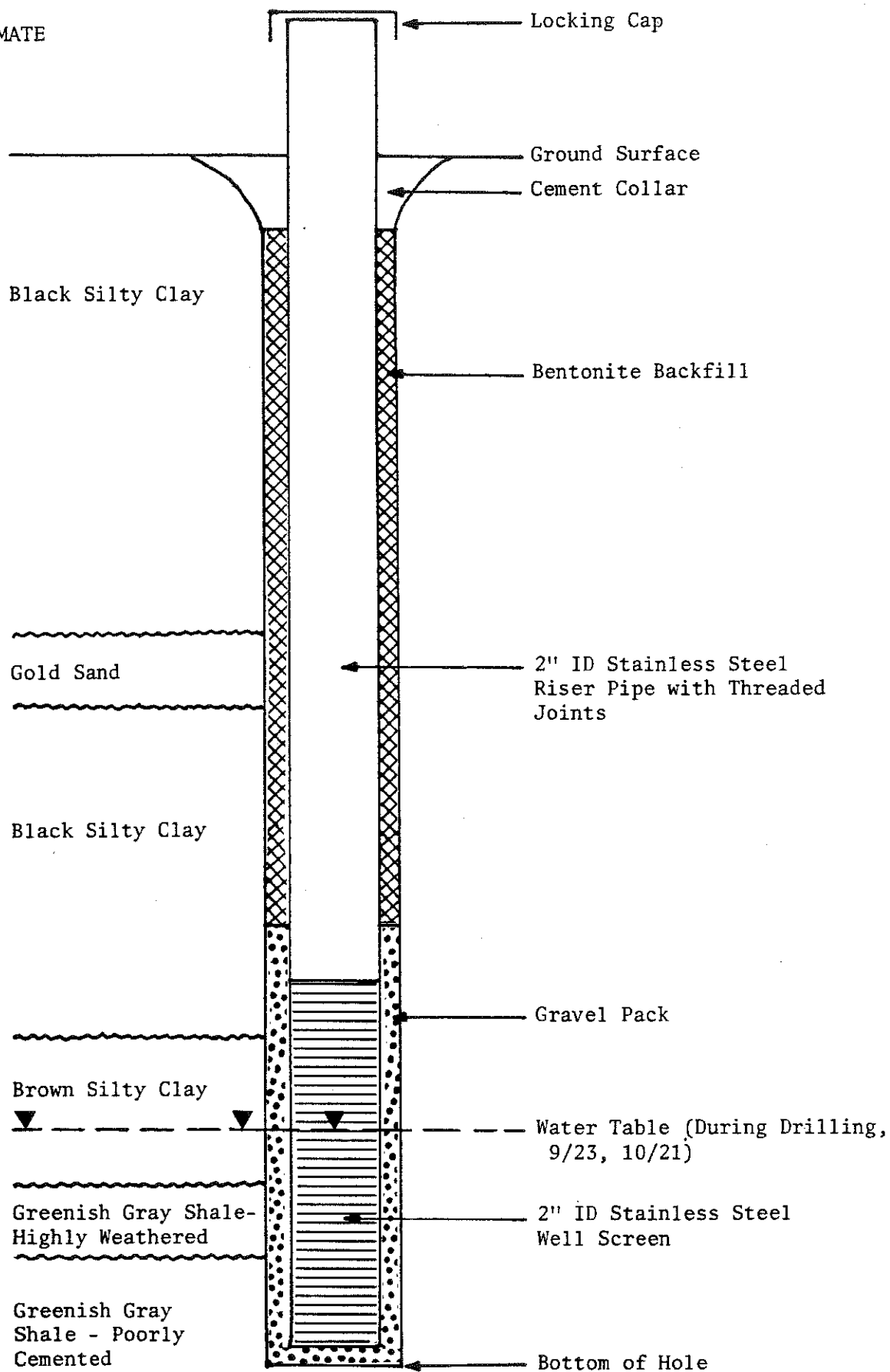


Figure 3. As-built Design of Monitor Well No. G-2

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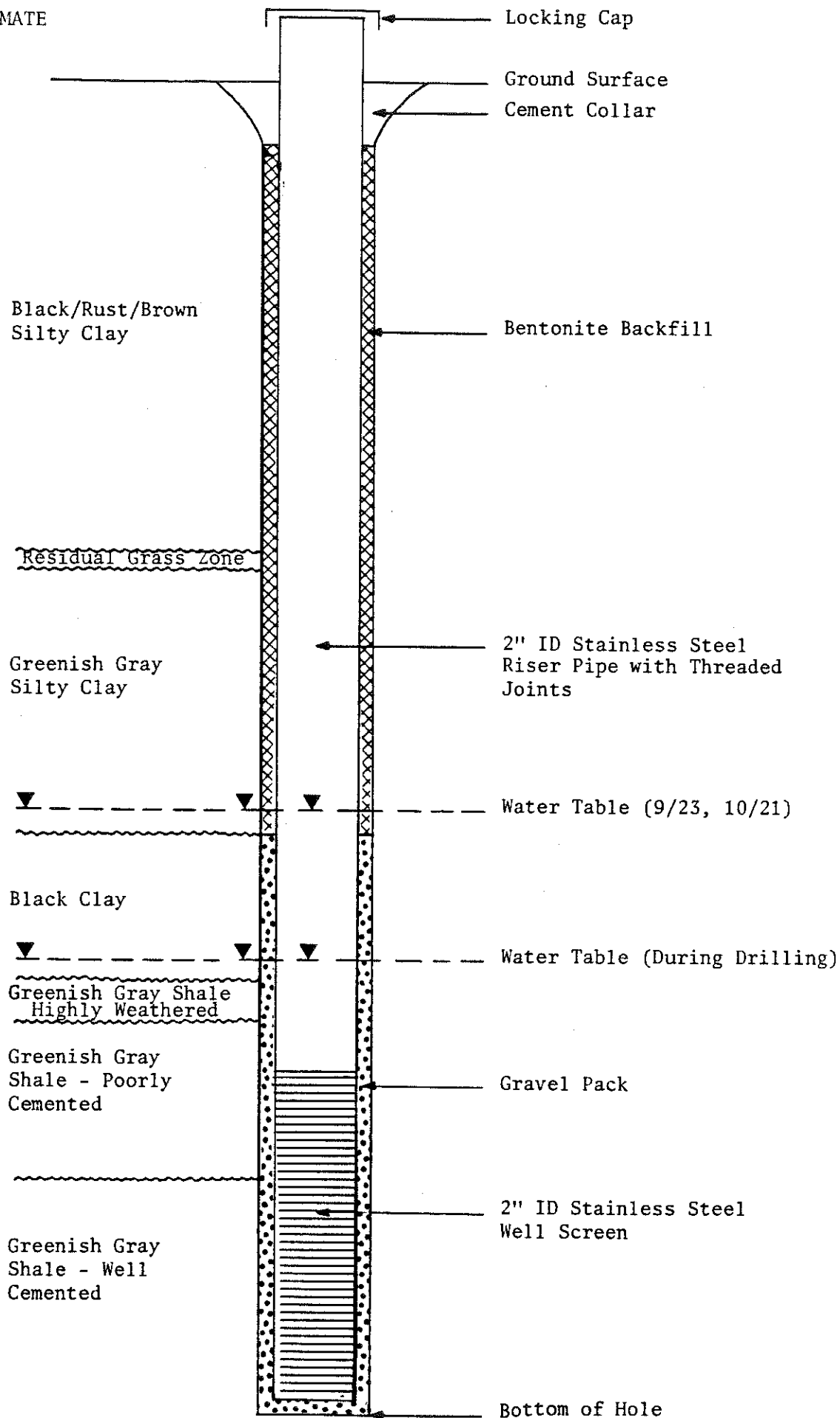


Figure 4. As-built Design of Monitor Well G-3

SCALE APPROXIMATE

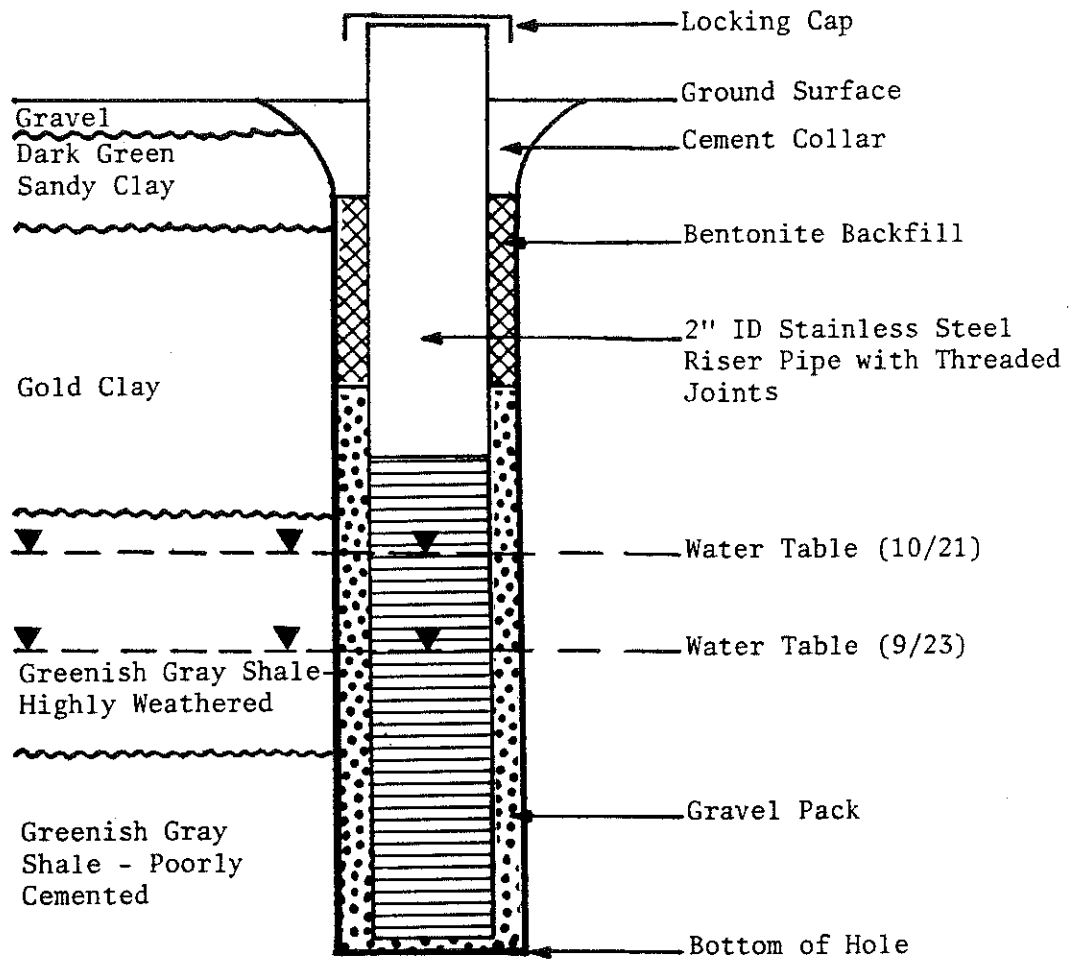


Figure 5. As-built Design of Monitor Well No. G-4

screen, capped at the bottom and the borehole was gravel packed to a point above the screen. The annular space, above the gravel pack, was backfilled to the surface with bentonite. A 2-foot cement collar was placed at the top of the borehole to hold the well securely in place and to direct runoff away from the casing. The top of the casing was fitted with a locking cap.

Each well was developed with compressed air to avoid sample dilution with development water. A hose was extended to the bottom of the well and water and sediment were removed by surging. (The plan called for sampling before the wells were developed with water. Since the sampling phase was delayed by one week, the wells were developed with compressed air.) Horizontal and vertical control for the monitor wells was supplied by Frank B. Krause & Associates (see Figure 1 and Table 1).

3.2 Sample Collection

Water samples were collected on September 23 and on October 21, 1982 by Wadsworth Testing Laboratories, Inc. from the four monitoring wells, the surface water upstream and downstream of the site, and at outfall 001. One grab sample was collected from the standing water in the northeast corner and from each of the standpipes in the northeast (T1) and southwest (T2) corners of the tank farm. A grab sample was also collected from the interceptor sewer (I1) before discharge to the API Separator at the same time that a third sample was collected from outfall 001.

The sample collection procedures described in the Plan and Implementation Schedule dated August 23, 1982 were followed. The water levels measured prior to sample collection are shown in Table 2. All monitor well samples were collected with a stainless steel bailer, stream and outfall samples were collected directly into sample bottles, and the water in the tank farm and interceptor sewer was pumped.

The field data was recorded and sample preservation was in accordance with "Methods for Chemical Analysis of Water and Wastes" (1974), USEPA 625/6-74-003. All samples were iced and delivered to the laboratory for analysis. Chain-of-custody control was maintained throughout the sampling and analysis program. The sample collector initiated the chain-of-custody record when the well

Table 2. Water Level Information

Well Number	Elevation Top of Pipe	Depth to Water (ft)	Water Elevation	Date of Water Level	Depth to Water (ft)	Water Elevation	Date of Water Level
G-1	982.34	7.69	974.65	9/23/82	7.25	975.09	10/21/82
G-2	979.29	26.53	952.76	9/23/82	26.29	953.00	10/21/82
G-3	979.53	23.19	956.34	9/23/82	23.05	956.48	10/21/82
G-4	980.55	11.32	969.23	9/23/82	9.69	970.86	10/21/82

was sampled. This record travelled with the sample bottles to the laboratory. Sample bottles were sealed after collection and the condition of the seal was inspected prior to analysis.

4. LABORATORY RESULTS

The chemical analyses were performed by Wadsworth Testing Laboratories, Inc., in accordance with EPA methods contained in "Methods for Chemical Analysis of Water and Wastes" (1979), EPA 600/4-79-020, and "Microbiological Methods for Monitoring the Environment, Water and Wastes" (1978), EPA 600/8-78-017. Permeability tests were performed on unconsolidated materials collected at the site during two field studies performed by Triggs and Associates. The first set of samples was collected on May 7, 1982 and the second set on September 13 through 15, 1982, as part of this study.

4.1 Permeability

The K values determined for each sample are shown in Table 3. These results are discussed in Section 5.1.

4.2 Groundwater Quality

The results of the analyses of groundwater samples collected on September 23 and October 21 are presented in Tables 4 and 5. The results of the replicate analysis (for statistical evaluations) are shown separately in Table 6.

Well number G-1 reflects groundwater quality upgradient from the site. As can be seen in Table 4, the only upgradient concentration in excess of the EPA inorganic drinking water standards is the mercury level in the sample taken on October 21. Total organic carbon increased from 28.4 mg/l to 98.8 mg/l from September to October (see Table 5) and total organic halogen decreased from 0.025 mg/l to 0.021 mg/l during the same period. No organic constituent exceeded the EPA Suggested No Adverse Response Levels (see Section 6.2).

Wells number G-2 and G-3 indicate the water quality of the groundwater leaving the Hukill Chemical property. Only one heavy metal parameter, lead, was found in excess of the inorganic EPA drinking water standards (see Table 4). The lead concentration in well number G-3 was below the detection limit on September 23 but exceeded the standard on October 21. In addition, chloride was found at concentrations exceeding the standard in both downgradient wells

Table 3. Permeabilities of Subsurface Materials

Description of Materials ^a	Cross-section Reference ^b	Boring No. ^c	Depth (ft)	Permeability (cm/sec)	Date of Collection
Brown Silty Clay	A	B-5	5.0- 6.5	2.8×10^{-5}	5/7/82
Brown/Gray Silty Clay	B	G-4	3.0- 5.0	2.2×10^{-8}	9/14/82
Brown/Gray Silty Clay	C	B-6	5.0- 6.5	2.2×10^{-8}	5/7/82
Brown Silty Clay	D	B-4	9.5-10.0	8.6×10^{-8}	5/7/82
Decomposed Shale	E	G-1	8.5-10.0	2.4×10^{-8}	9/15/82
Brown/Gray Silty Clay	F	G-3	18.5-20.0	1.9×10^{-8}	9/13/82
Dark Gray Organic Clay	G	G-3	23.5-25.0	4.3×10^{-8}	9/13/82
Gray Silty Clay	H	G-2	23.0-25.0	2.5×10^{-8}	9/13/82

^a Laboratory description of materials.

^b See Figures 6 and 7 for vertical location of permeabilities.

^c See Figure 1 for location of borings.

Table 4. Concentrations of Inorganic Contaminants in Groundwater

Parameter (mg/l)	D.W. Standard ^a	UP		No.		NE		Cistern	
		Well No. G-1		Well No. G-2		Well No. G-3		Well No. G-4	
		9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82
Arsenic	0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium	1.0	0.1	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	0.01	< 0.01	0.01
Chromium	0.05	<0.02	<0.02	<0.02	0.02	< 0.02	0.02	< 0.02	< 0.02
Lead	0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	0.10 ^b	0.05	< 0.05
Mercury	0.002	<0.002	0.075 ^b	<0.005	<0.005	<0.002	<0.005	< 0.002	<0.005
Selenium	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	< 0.005	<0.005
Silver	0.05	<0.01	<0.01	<0.01	<0.01	< 0.01	< 0.01	< 0.01	0.02
Chloride	250	122	53	340 ^b	370 ^b	335 ^b	326 ^b	26	26
pH (field)	6.5-8.5	7.1	7.2	6.8	7.4	7.2	7.3	7.1	6.6
Chemical Oxygen Demand	-	62	17	25	230	225	176	22	< 5

^a Chloride and pH are secondary EPA drinking water standards (40 CFR 143). The remaining standards (40 CFR 141) shown are primary (health related).

^b Concentrations in excess of the EPA drinking water standards.

Table 5. Concentrations of Organic Contaminants in Groundwater

Parameter (ppm) ^a	SNARL ^b (Exposure)	Well No. G-1		Well No. G-2		Well No. G-3		Well No. G-4	
		9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82
Total Organic Carbon ^c	-	28.4	98.8	20.7	117.0	389.5	248.0	23.8	102.0
Total Organic Halogen	-	0.025	0.021	0.066	0.043	0.063	0.028	0.112	0.042
1,1-Dichloroethane	-	-	-	tr ^e	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	0.040	-	-	tr ^e	tr ^e
Ethylbenzene	-	-	-	-	-	-	-	-	-
Methylene Chloride	13 (1 day)	-	-	-	-	-	-	0.08	tr ^e
Tetrachloroethylene	2.3 (<1 day)	-	-	-	-	-	-	tr ^e	tr ^e
Toluene	1 (<1 year)	-	-	-	-	-	-	tr ^e	tr ^e
1,1,1 Trichloroethane	0.33 (1 day)	-	-	tr ^e	0.030	-	-	tr ^e	-
Trichloroethylene	2.02 (1 day)	-	-	tr ^e	0.012	-	-	0.04	0.045
Other Priority Organics	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	12 (1 day)	-	-	-	-	-	-	-	tr ^e
Acetone, MEK ^d	7.5 (1 day)	<0.5	<1.0	0.5	<1.0	0.5	<1.0	0.5	<1.0
Aliphatic Hydrocarbons	-	-	-	0.01-0.05	0.05-0.10	tr ^e	0.01-0.02	-	-

^a Total organic carbon and total organic halogen are in mg/l.

^b EPA Suggested No Adverse Response Levels for drinking water in mg/l (see Section 6.2 for discussion). Methylene chloride, xylenes and methyl ethyl ketone are draft SNARLS (4/82). The remaining SNARLS shown were issued on April 28, 1980, by the Office of Drinking Water.

^c Values reported for September 23, 1982 are the average of four replicates (see Table 6).

^d MEK is methyl ethyl ketone. Values reported for September 23, 1982, are acetone only. Values reported for October 21, 1982, are acetone and MEK combined. The SNARL shown is for MEK.

^e Trace, indicates greater than 1 ppb.

Table 6. Concentrations in Replicate Sample Analyses

Parameter	Surface Water			Groundwater			
	Upstream (S-B)	Outfall 001 (S-A)	Downstream (S-C)	G-1	G-2	G-3	G-4
TOC-1 (mg/l)	25.2	54.2	32.9	36.3	22.8	417	22.2
TOC-2 (mg/l)	18.2	51.7	29.7	20.1	20.0	395	23.3
TOC-3 (mg/l)	16.5	51.1	27.5	21.9	20.0	373	23.8
TOC-4 (mg/l)	20.3	54.2	34.6	35.2	20.0	373	26.0
TOC-Average (mg/l)	20.0	52.8	31.2	28.4	20.7	389.5	23.8
pH-1	7.5	7.2	7.3	7.1	6.8	7.2	7.1
pH-2	7.2	7.4	7.4	7.6	6.9	7.4	7.0
pH-3	7.0	7.4	7.5	7.7	6.8	7.5	7.0
pH-4	7.7	7.7	7.5	7.7	7.0	7.6	6.7
pH-Average	7.3	7.4	7.4	7.5	6.9	7.4	6.9

during both sampling periods. Total organic carbon increased in well number G-2 from 20.7 mg/l to 117.0 mg/l and decreased in well number G-3 from 389.5 mg/l to 248.0 mg/l from September to October. The total organic halogen concentrations decreased in both wells from 0.066 mg/l to 0.043 mg/l (G-2) and from 0.063 mg/l to 0.028 mg/l (G-3) from September to October. No organic constituent exceeded the EPA Suggested No Adverse Response Levels in drinking water.

Well number G-4 is located in such a manner as to provide an indication of the groundwater quality in the vicinity of the buried cistern. There were no violations of the inorganic EPA drinking water standards. Total organic carbon increased from 23.8 mg/l to 102.0 mg/l and total organic halogen decreased from 0.112 mg/l to 0.042 mg/l from September to October. No organic constituent exceeded the EPA Suggested No Adverse Response Levels for drinking water.

4.3 Surface Water Quality

The results of the analyses of water samples collected on September 23 and October 21 are shown in Tables 7 and 8. The results of the replicate analyses (for statistical evaluations) are shown separately in Table 6.

The upstream surface water quality was measured at a point sufficiently downstream from the culvert to be representative of overall surface water quality. As can be seen in Table 7, the mercury concentrations were in excess of the EPA inorganic drinking water standards on October 21. Total organic carbon and total organic halogen both increased from September to October (see Table 8). No organic constituent was found in excess of the EPA Suggested No Adverse Response Levels for drinking water (see Section 6.2) but acetone was found at 1.5 ppm on September 23.

The outfall was sampled before mixing with the receiving water. There were no constituents found in excess of the EPA inorganic drinking water standards. The maximum concentration of TOC increased from 54.2 mg/l on September 23, to 92.9 mg/l on October 21, and to a maximum concentration of 112 mg/l on November 18. Since the NPDES permit for the facility limits TOC to a daily

Table 7. Concentrations of Inorganic Contaminants in Surface Water

Parameter (mg/l)	D.W. Standard ^a	Upstream (S-B)		Outfall 001 (S-A)		Downstream (S-C)	
		9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82
Arsenic	0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium	1.0	0.2	<0.1	0.6	<0.1	<0.1	<0.1
Cadmium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	0.05	<0.02	<0.02	<0.02	0.02	<0.02	<0.02
Lead	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	0.002	<0.002	<u>0.016</u> ^b	<0.002	<0.005	<0.005	<0.005
Selenium	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silver	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride	250	46	46	32	75	37	60
pH (field)	6.5-8.5 ^c	7.2	7.7	7.4	7.1	7.3	7.7
Chemical Oxygen Demand	-	102	13	160	203	98	79

^a Chloride and pH are secondary EPA drinking water standards (40 CFR 143). The remaining standards (40 CFR 141) shown are primary (health related).

^b Concentration in excess of the EPA drinking water standards.

^c pH is limited to 6.0 to 9.0 by the NPDES permit.

Table 8. Concentrations of Organic Contaminants in Surface Water

Parameter (ppm) ^a	SNARL ^b (Exposure)	Upstream (S-B)		Outfall 001 (S-A)		Downstream (S-C)	
		9/23/82	10/21/82	9/23/82	10/21/82	9/23/82	10/21/82
Total Organic Carbon ^c	-	20.0	31.1	52.8	92.9 ^d	31.2	39.2
Total Organic Halogen	-	0.066	0.102	5.28	0.092 ^d	0.303	0.252
1,1 Dichloroethane	-	-	-	-	-	-	-
1,1 Dichloroethylene	-	-	-	-	-	tr ^e	0.020
Ethylbenzene	-	-	-	-	-	-	-
Methylene Chloride	13 (1 day)	0.01	-	14 ^f	0.032	0.22	0.230
Tetrachloroethylene	2.3 (<1 day)	0.01	-	-	-	-	-
Toluene	1 (<1 year)	-	-	0.16	0.022	-	0.010
1,1,1 Trichloroethane	0.33 (1 day)	-	-	0.26	-	tr ^e	-
Trichloroethylene	2.02 (1 day)	-	0.660	0.11	-	-	0.016
Other Priority Organics	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	12 (1 day)	-	-	0.4	0.052	-	-
Methyl Ethyl Ketone	7.5 (1 day)	-	-	-	4	-	-
Acetone	-	1.5	<1 ^g	20	8	4	<1 ^g
Aliphatic Hydrocarbons	-	-	-	-	-	-	-

^a Total organic carbon and total organic halogen are in mg/l.

^b EPA Suggested No Adverse Response Levels for drinking water in mg/l (see Section 6.2 for discussion). Methylene chloride, xylenes and methyl ethyl ketone are draft snarls (4/82). The remaining snarls shown were issued on April 28, 1980 by the Office of Drinking Water.

^c Values reported for September 23, 1982 are the average of four replicates (see Table 6).

^d Sample container was broken. Sample analyzed was not preserved nor cooled.

^e Trace, indicates greater than 1 ppb.

^f Concentration in excess of EPA drinking water SNARL.

^g Values include acetone and methyl ethyl ketone.

average of 60 mg/l and a daily maximum of 90 mg/l, the outfall was not in compliance with the TOC limits on October 21 and November 18. Total organic halogen (TOX) increased from 5.28 mg/l to 6 mg/l from September to November. The October TOX sample analysis probably indicated values below the actual value because the sample bottle was broken and had to be replaced with a non-preserved, non-chilled sample. Methylene chloride, measured at 14 ppm on September 23, was the only organic constituent found in excess of the EPA Suggested No Adverse Response Level (SNARL) for drinking water. Since the SNARL for methylene chloride (13 mg/l) is related to drinking water for a one-day period, a concentration of 14 ppm in effluent does not appear to be a significant deviation. It should be noted that this value dropped to 0.032 ppm by October 21 and to 0.80 ppm by November. Acetone was measured at 20 ppm in September, 8 ppm in October, and 3 ppm in November.

The downstream surface water sample was collected north of the facility (see Figure 1) at a point indicative of the influence of groundwater runoff on surface water quality. There were no constituents measured in excess of either the EPA inorganic standards or Suggested No Adverse Response Levels for drinking water. Acetone was measured at 4 ppm in September.

4.4 Other Chemical Analyses

Grab samples of specific sources were collected to supplement this study. These samples included water from the standpipes in the northeast (T1) and southwest (T2) corners of the solvent tank farm, standing water in the northeast (T1) corner of the solvent tank farm, water from the interceptor sewer (I1) before it entered the API Separator, and a third sample from outfall 001 (S-A) (see Figure 1). The standing water sample was collected on October 21. The remaining samples were collected on November 18 (see Tables 9 and 10).

The grab sample of the standing water in the northeast corner of the solvent tank farm contained both cadmium and lead in excess of the inorganic EPA drinking water standards. Chloride was measured at 74 mg/l. The total organic carbon was measured at 441.0 mg/l and the total organic halogen at 9.52 mg/l in October. The following four organic compounds were found at levels that exceeded the EPA Suggested No Adverse Response Levels for drinking water:

Table 9. Concentrations of Inorganic Contaminants in Various Sources

Parameter (mg/l)	D.W. Standard ^a	Solvent Tank Farm			Effluent	
		Standing Water NE Corner ^b	Standpipe ^b NE Corner	Standpipe ^b SW Corner	Outfall 001 ^b	Interceptor Sewer ^b
Arsenic	0.05	<0.005	<0.01	<0.01	<0.01	<0.01
Barium	1.0	0.20	<0.1	<0.1	<0.1	<0.1
Cadmium	0.01	<u>0.03</u> ^c	<0.01	<u>0.04</u> ^c	<0.01	<0.01
Chromium	0.05	<0.02	<0.02	<u>0.55</u> ^c	<0.02	<0.02
Lead	0.05	<u><0.09</u> ^c	<0.05	<u>1.0</u> ^c	<0.05	<0.05
Mercury	0.002	<0.002	<0.01 ^d	<0.01 ^d	<0.01 ^d	<0.01 ^d
Selenium	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Silver	0.05	0.01	<0.01	<0.01	<0.01	<0.01
Chloride	250	74	85	17	34	34
pH (field)	6.5-8.5	7.2	6.5	8.5	6.8	6.7
Chemical Oxygen Demand	-	1030	3510	3020	155	126

Notes:

^a Chloride and pH are secondary EPA drinking water standards (40 CFR 143). The remaining standards (40 CFR 141) shown are primary (health related).

^b See Figure 1 for location of sampling points. The sample of standing water in the NE corner of the solvent tank farm was collected on October 21, 1982. The remaining samples were collected on November 18, 1982.

^c Concentrations in excess of the EPA drinking water standard.

^d The detection levels for mercury were high due to the high concentration of organic compounds.

Table 10. Concentrations of Organic Contaminants in Various Sources

Parameter (ppm) ^a	SNARL ^b (Exposure)	Solvent Tank Farm			Effluent	
		Standing Water NE Corner ^c	Standpipe NE Corner ^c	Standpipe SW Corner ^c	Outfall 001 ^c	Interceptor Sewer ^c
Total Organic Carbon	-	441.0	1,800	377	112	96.4
Total Organic Halogen	-	9.52	-	-	6	-
Methylene Chloride	13(1 day)	$\frac{16^d}{4.5^d}$	$\frac{6,000^d}{45^d}$	$\frac{80^d}{20^d}$	0.80	$\frac{2^d}{9^d}$
1,1,1 Trichloroethane	0.33(1 day)	$\frac{4.5^d}{4^d}$	$\frac{40^d}{35^d}$	$\frac{35^d}{3^d}$	0.17	$\frac{2^d}{3^d}$
Toluene	1(<1 year)	$\frac{30^d}{15^d}$	$\frac{100^d}{300^d}$	$\frac{50^d}{5^d}$	0.35	$\frac{3}{2}$
Acetone	-	-	-	-	3	2
Methyl Ethyl Ketone	7.5(1 day)	-	-	-	1.6	1
Methyl Iso-Butyl Ketone	-	-	-	-	0.30	0.2-0.5
Trichloroethylene	2.02(1 day)	1.3	$\frac{10^d}{2}$	$\frac{5^d}{20^d}$	0.02	-
Ethylbenzene	-	0.40	4	-	0.02	0.2
Xylenes	12(1 day)	1.8	1	-	0.20	0.2-0.5
Dichloroethylene	-	-	1	3 ^d	-	0.2-0.5
Freons	-	-	-	-	-	0.2-0.5
Tetrachloroethylene	2.3(1 day)	0.20	-	-	-	0.2-0.5 ^d
Ethanol	-	-	-	-	-	0.2-0.5
Chloroform	0.1(life time)	-	-	4 ^f	-	-
Cyclohexane	-	-	2	-	-	0.2-0.5
Hexane	-	-	-	-	-	0.2-0.5
Dichloroethane	-	-	-	-	-	<0.10
Other Organics	-	<1	<1	<1	<0.01	<0.10

^a Total organic carbon and total organic halogen are in mg/l.

^b EPA Suggested No Adverse Response Levels for drinking water in mg/l (see Section 6.2 for discussion). Methylene chloride, xylenes, methyl ethyl ketone are draft SNARLs (4/82). The remaining SNARLS shown were issued on April 28, 1980 by the Office of Drinking Water.

^c See Figure 1 for location of sampling points. The sample of standing water in the NE corner of the solvent tank farm was collected on October 21, 1982. The remaining samples were collected on November 18, 1982.

^d Concentration in excess of EPA drinking water SNARL.

^e Value includes acetone and methyl ethyl ketone.

^f Value includes hexane and cyclohexane.

methylene chloride, toluene, 1,1,1 trichloroethane, and methyl ethyl ketone. Acetone was found at 30 ppm.

The water in the standpipe in the northeast corner of the solvent tank farm contained no inorganic constituents in excess of the EPA drinking water standards. Chloride was measured at 85 mg/l. The total organic carbon was measured at 1,800 mg/l. The following five organic compounds were found at levels that exceeded the EPA SNARLS for drinking water: methylene chloride, 1,1,1 trichloroethane, toluene, methyl ethyl ketone, and trichloroethylene. Acetone was found at less than 100 ppm.

The water in the standpipe in the southwest corner of the solvent tank farm contained cadmium, chromium, and lead in excess of the EPA drinking water standards. Chloride was measured at 17 mg/l. Total organic carbon was measured at 377 mg/l. The following six organic compounds were found at levels that exceeded the EPA SNARLS for drinking water: methylene chloride, 1,1,1 trichloroethane, toluene, methyl ethyl ketone, xylenes, and tetrachloroethylene. Acetone was found at less than 50 ppm.

The grab sample from the interceptor sewer contained no inorganic constituents in excess of the EPA drinking water standards. Chloride was measured at 34 mg/l. Total organic carbon was measured at 96.4 mg/l. Three organic compounds were found in excess of the EPA SNARLS for drinking water. They were 1,1,1 trichloroethane, toluene, and chloroform.

5. HYDROGEOLOGIC SETTING

The monitor well installation program provided information concerning the subsurface materials at the site from the data collected during the drilling and logging of the boreholes. The well records were used to prepare the geologic cross-sections of the materials beneath the site. Water levels measured during two periods of sample collection (one month apart), combined with the results of the survey, provided the information necessary for the construction of groundwater flow diagrams. These diagrams, plus the soil permeability tests, were used to estimate a groundwater flow rate.

5.1 Subsurface Materials

The data obtained from the borehole logs suggests that the entire facility is underlain by greenish-gray shale bedrock and that this bedrock displays two distinct zones of weathering. The unweathered bedrock is well-cemented, silt-sized particles displaying good fracture. The weathered zone immediately above the shale bedrock can be distinguished predominantly due to its poor cementing. Above this zone, the weathered shale borders on clayshale but fracture is still evident. Split-spoon samples were collected of all three zones of shale bedrock but permeabilities could be determined on only the upper weathered zone because of the high incidence of fracture. This upper zone exhibited a permeability of 2.4×10^{-8} cm/sec. This zone is also the lowest point that water was first encountered during drilling. Both the poorly cemented weathered shale and the weathered clayshale thin to the north beneath the facility.

On the southern portion of the facility, gold-to-brown sandy clay overlies the weathered shale. This clay contains evidence of solution veins and angular pebbles of clay shale, and the permeability was measured at 2.2×10^{-8} cm/sec. Finally, the surficial materials are black-to-dark-green sandy clay.

On the northern portion of the facility, the sequence of unconsolidated materials is more complicated. To the east (in borehole G-3) wood chips are found in the material immediately overlying the uppermost weathered shale. This material appears to be organic (based on soil structure). Above that lies

silty clay with shale fragments and more wood chips followed by a residual grass zone that is just beginning to decompose (the blades of grass are distinguishable but black in color). The upper fill is basically silty clay in three layers (distinguishable by color) with cinders and roots scattered throughout.

To the west in the northern portion (in borehole G-2), the material directly above the uppermost weathered shale is a laminated brown silty clay with some pebbles. Above it is black silty clay with pebbles and cinders extending to the surface. This upper material contains a thin bed of gold sand.

Examination of the cross-sections (see Figures 6 through 8), suggests that a depression was formed across the northern portion of the site. This depression was apparently cut through the weathered shale and into bedrock. The newly exposed bedrock then weathered for a period of time (thus explaining the thinning of the weathered bedrock units) before filling of the depression began.

5.2 Groundwater Flow

The water levels measured on September 23 in the monitoring wells suggest that the slope of the southern portion of the water table is approximately 115 feet per mile (0.021) through the undisturbed materials (see Figure 9). As the groundwater flows downgradient to the north-northeast, the gradient increases sharply as the groundwater flows into the depression. On the northern half of the site, the slope of the water table increases to approximately 425 feet per mile (0.080), making the overall gradient approximately 260 feet per mile (0.049).

The water levels measured on October 21 indicate that the slope of the water table in the northern portion of the site did not change. The water table in the southern portion of the site increased by approximately one foot (see Figure 10) but the change was not large enough to impact the overall gradient.

Darcy's law was used to approximate the rate of groundwater flow. Using an average permeability of 2.24×10^{-8} cm/sec for the materials in the saturated

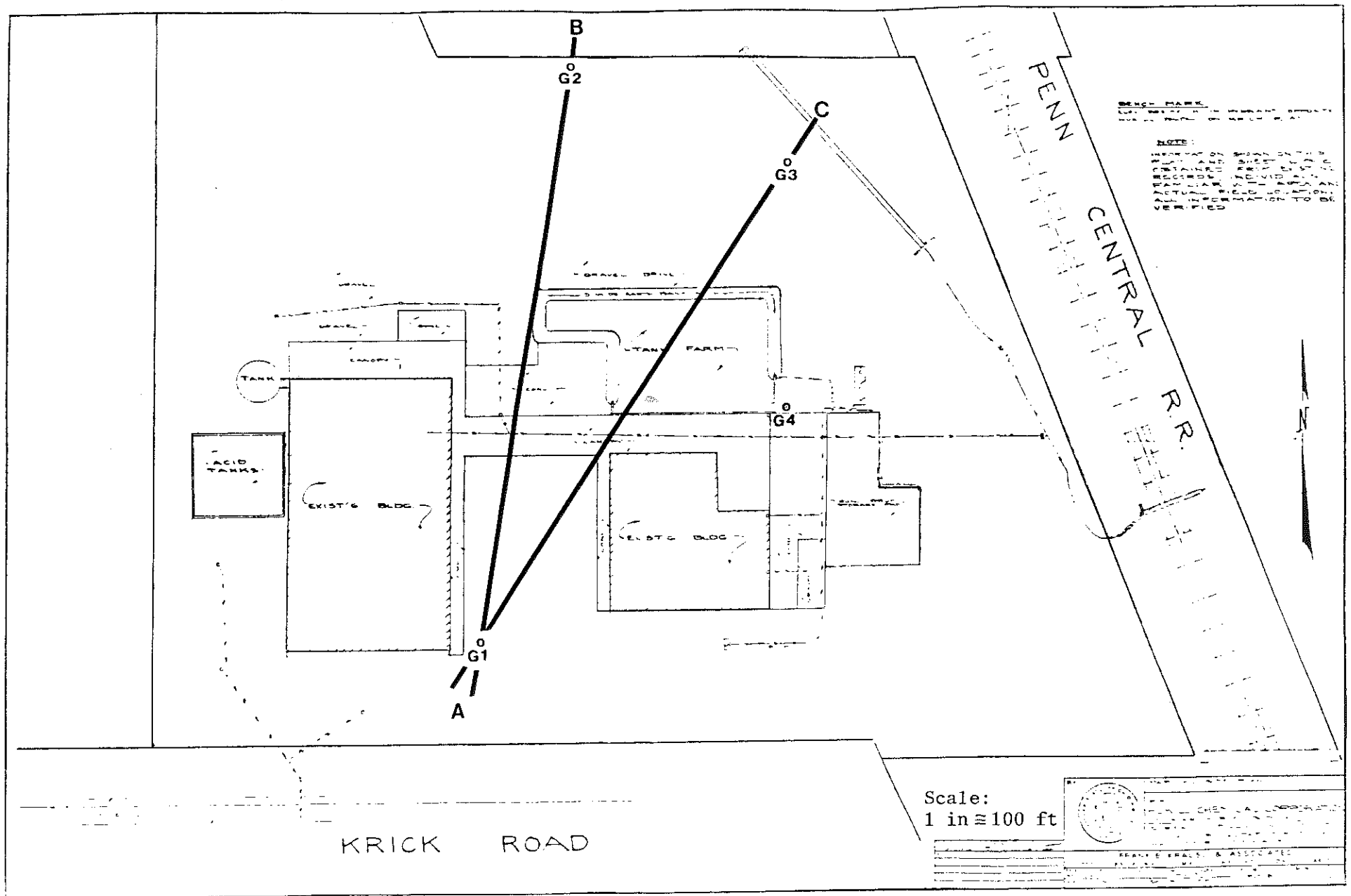
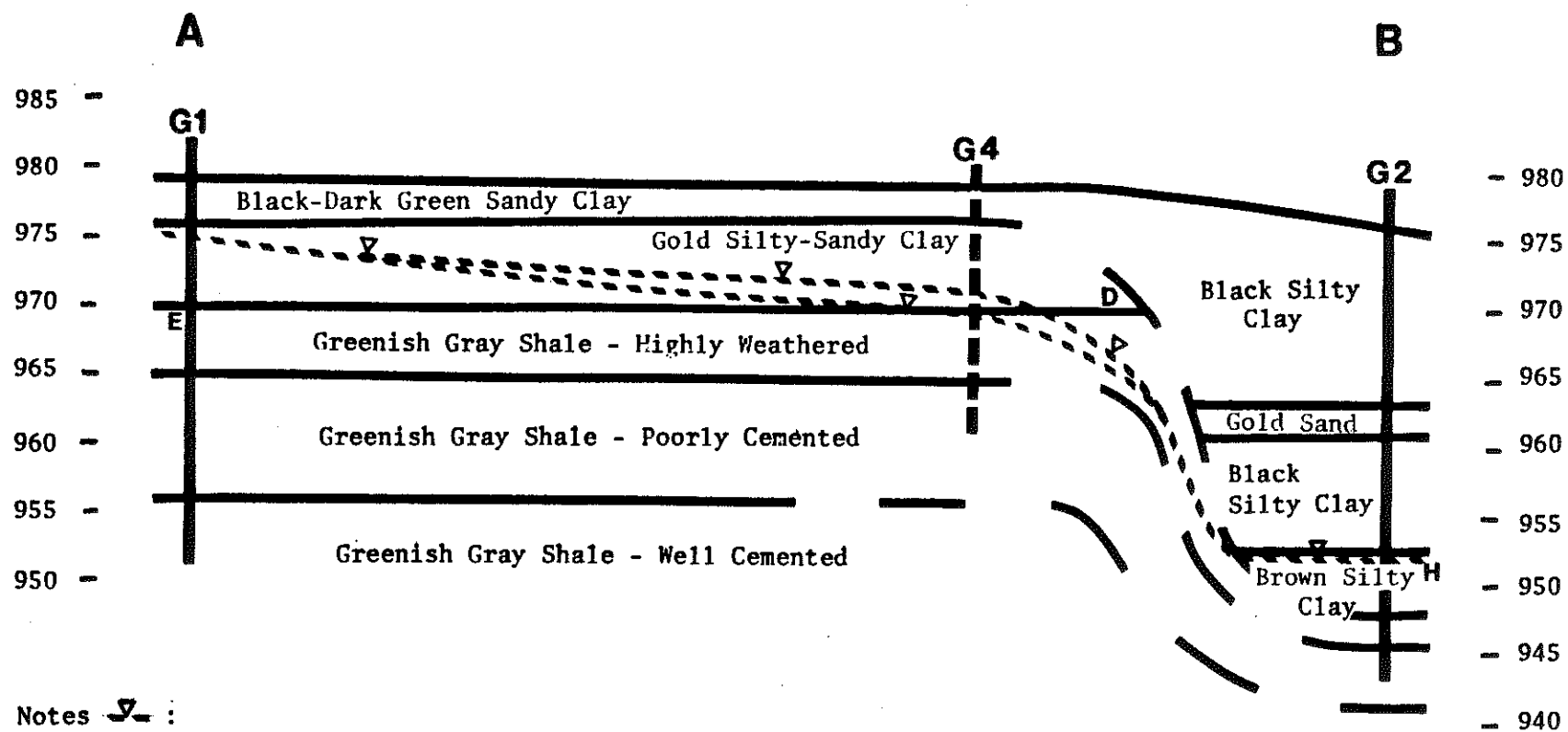


Figure 6. Location of Cross-sections A-B and A-C



Notes ∇ :

Upper - Inferred Water Table 10-21-82

Lower - Inferred Water Table 9-23-82

D - Location of Permeability Samples

Figure 7. Cross-Section A-B

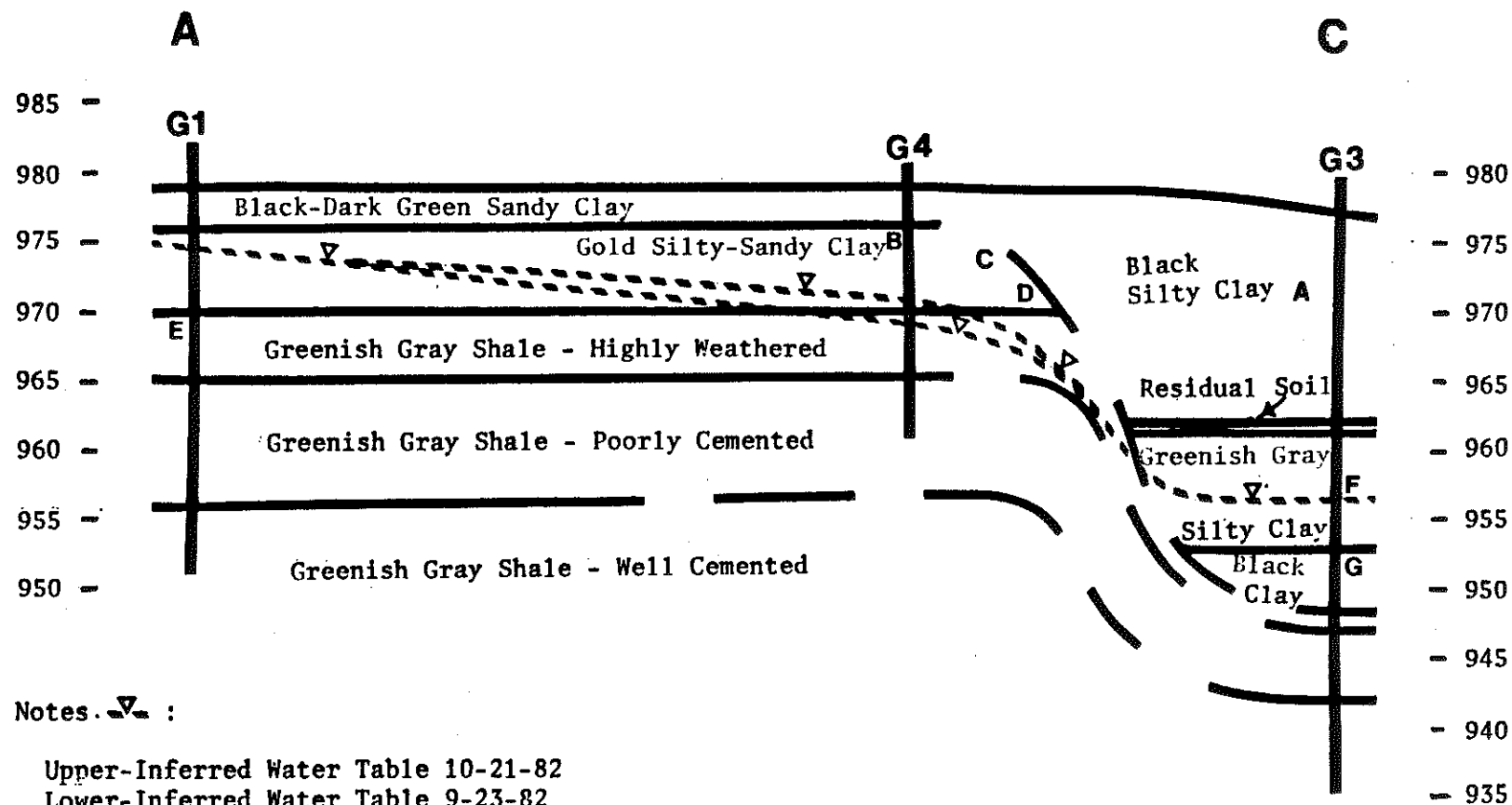


Figure 8. Cross-Section A-C

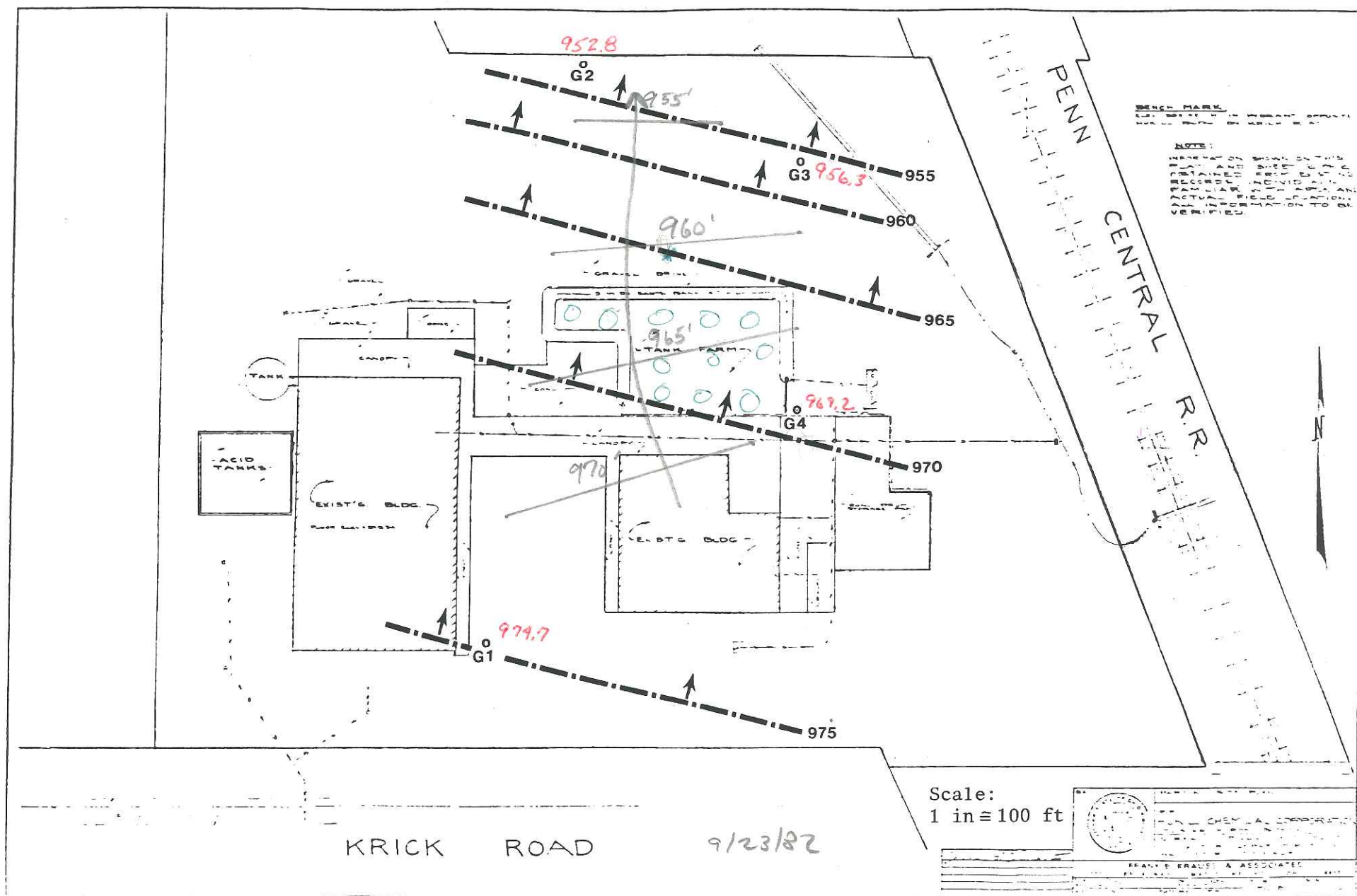


Figure 9. Groundwater Elevations Measured September 23, 1982

Figure 10. Groundwater Elevations Measured October 21, 1982

zone and assuming an average porosity of 33.5 percent (the total porosity is equal to the effective porosity in unconsolidated sediments), a groundwater flow velocity of 3.3×10^{-9} cm/sec (3.4×10^{-3} ft/yr) was estimated.

6. WATER QUALITY EVALUATION

Four separate evaluation techniques were applied to the groundwater and surface water quality data presented in Section 4. Where appropriate, the EPA inorganic standards or Suggested No Adverse Response Levels (organic SNARLS) for drinking water were compared to the concentrations found in surface water and groundwater at the facility. Statistical comparisons of TOC concentrations and pH were performed and the indicator parameter data was examined for trends.

This evaluation (described in the following sections) led to the following conclusions concerning the groundwater and surface water quality:

1. The primary drinking water standards were exceeded for only two parameters:
 - Both upgradient and upstream water quality exceeded the standard for mercury on October 21.
 - The groundwater in well number G-3 exceeded the standard for lead on the same date.
2. The secondary drinking water standard for chloride was exceeded in both downgradient wells (G-2 and G-3) on both sampling dates.
3. The EPA Suggested No Adverse Response Levels for drinking water were not exceeded in either surface water or groundwater but outfall 001 exceeded the SNARL for methylene chloride on September 23.
4. The statistical comparisons of surface water quality in terms of TOC suggested that outfall 001 had an effect on surface water quality.
5. Similar statistical comparisons suggested that the TOC in the groundwater in wells number G-1, G-2, and G-4 is similar.

6.1 Inorganic Standards

EPA has established Maximum Contaminant Levels (MCL Standards) for specific inorganic parameters in water used for public water supplies. These parameters have been placed in two categories: primary and secondary. The primary standards are judged to be necessary to protect public health (40 CFR 141), while the secondary standards are designed to protect the public welfare (40 CFR 143). Although these standards are widely applied to water quality evaluations, it is important to note that they apply to drinking water in public water supply systems, not to water quality in general. That is, they are not ambient water quality standards for either surface water or groundwater. These standards are shown in Tables 4 and 7.

There is only one instance where the health-related standards for drinking water are exceeded in the groundwater leaving the site. The sample collected on October 21 from well number G-3 contained 0.10 mg/l of lead, but the other three downgradient groundwater samples were less than the primary standard of 0.05 mg/l. The secondary chloride standard (250 mg/l) was exceeded in all samples of groundwater leaving the site (340 mg/l, 370 mg/l, 335 mg/l, and 326 mg/l), while the groundwater entering the site contained 122 mg/l and 53 mg/l of chloride. These data indicate that chloride concentrations are increasing as the groundwater passes beneath the Hukill Chemical facility. The samples analyzed for the inorganic constituents in the groundwater downgradient of the buried cistern indicate that the EPA drinking water standards are not exceeded in either set of samples.

The only constituent found in surface water in excess of the EPA inorganic drinking water standards was mercury in the upstream sample collected on October 21. Neither the outfall nor the downstream samples contained concentrations of any inorganic parameters measured in excess of the standard.

6.2 Organic SNARLS

The Office of Drinking Water provides Suggested No Adverse Response Levels (SNARLS) for some unregulated drinking water contaminants. These levels include a margin of safety and are based on drinking the contaminated water

over a specified period of time. EPA cautions that a SNARL does not condone the presence of a contaminant in drinking water, but does provide useful information in determining the significance of concentrations found.

No volatile organic compounds were found in groundwater in excess of the EPA SNARLS.

There were no volatile organic compounds measured in surface water in excess of the SNARLS. On September 23, methylene chloride in outfall 001 was slightly over the suggested level, but had dropped below that level by October. Although there is no SNARL for acetone, the September levels in the upstream (1.5 ppm) and downstream (4 ppm) samples had dropped to below-detection-levels by October and therefore do not appear significant.

6.3 Statistical Comparisons

Statistical comparisons of the pH and TOC of samples collected on September 23 were performed using the Student's t-test at the 0.01 level of significance with six degrees of freedom (see Appendix B). A one-tailed test was used for the evaluation of changes in TOC, since only increases are significant. A two-tailed test was used for pH since both increases and decreases are significant. The results of these comparisons are presented in Table 11 and indicate the following in terms of TOC and pH:

- The downgradient groundwater quality, in terms of TOC on the western portion of the facility, is not significantly different from the upgradient groundwater quality.
- The downgradient groundwater, on the eastern portion of the facility, contains significantly greater concentrations of TOC than does the upgradient groundwater.
- Conversely, the upgradient groundwater is not significantly different, in terms of pH, from the downgradient groundwater.

Table 11. Statistical Comparisons for TOC and pH

Statistical Comparison	TOC			pH		
	Calculated t	Table t	Sig.	Calculated t	Table t	Sig.
Downgradient to Upgradient (G-2 to G-1)	-1.775	3.707	No	-4.309	4.317	No
Downgradient to Upgradient (G-3 to G-1)	31.764	3.707	Yes	-0.600	4.317	No
Downgradient to Downgradient (G-3 to G-2)	34.941	3.707	Yes	5.643	4.317	Yes
Cistern to Upgradient (G-4 to G-1)	-1.056	3.707	No	-3.406	4.317	No
Downgradient to Cistern (G-3 to G-4)	34.624	3.707	Yes	3.869	4.317	No
Downgradient to Cistern (G-2 to G-4)	-2.919	3.707	No	-0.810	4.317	No
Downstream to Upstream (S-C to S-B)	4.541	3.707	Yes	0.432	4.317	No
Outfall to Upstream (S-A to S-B)	15.947	3.707	Yes	0.377	4.317	No
Outfall to Downstream (S-A to S-C)	12.074	3.707	Yes	-	-	No

- o The downgradient groundwater on the western portion of the facility is significantly different, in terms of TOC and pH, from the downgradient groundwater on the eastern portion.
- o The groundwater in the vicinity of the buried cistern is not significantly different, in terms of TOC or pH, from the upgradient groundwater or the downgradient groundwater on the western portion of the facility but is significantly lower, in terms of TOC, than the downgradient groundwater on the eastern portion.
- o The downstream TOC is significantly greater than the upstream TOC.
- o The outfall TOC is significantly greater than either the upstream or downstream TOC.
- o The pH in the outfall and in the upstream and downstream samples is not significantly different.

Based on the above findings, two conclusions can be drawn. First, the total organic carbon concentration in the downgradient groundwater on the eastern portion of the facility is significantly higher than that entering the site and that immediately upgradient of the north tank farm. The source of the total organic carbon appears to be localized since the concentrations in well number G-2 are also similar to those entering the site. Second, the TOC concentrations in the outfall are significantly higher than either the upstream or downstream concentrations but the pH is not. The pH comparisons for groundwater are less straightforward. Examination of the data suggests that wells number G-1 and G-3 are similar and that wells number G-2 and G-4 are similar. However, the small variance within the data for well number G-2 limits the statistical results of the comparisons as does the logarithmic nature of pH.

6.4 Indicator Parameters

Three indicator parameters for organic compounds were used in this study. These parameters are chemical oxygen demand (COD), total organic carbon (TOC),

and total organic halogen (TOX). The use of COD is based on the assumption that all organic compounds can be oxidized to carbon dioxide and water. The results are reported as milligrams of oxygen per liter. This test cannot distinguish between biologically oxidizable and biologically inert organic matter. TOC is a more direct expression of the amount of organic matter than is COD. TOC consists of dissolved organic carbon and suspended organic carbon. TOX represents a class of organic compounds that contains any of the halogens--chlorine, bromine, or iodine. In most cases, halogens are not naturally occurring.

Typical study design would incorporate the analysis of indicator parameters in the first phase of data collection and evaluation. The presence of high concentrations of any of these indicators would then trigger a more detailed analysis of individual organic compounds. In this study, both analyses were done concurrently so that the results could be interpreted over a shorter time frame. It should be recognized that changes in indicator parameters cannot be interpreted in a manner similar to that used for individual organic compounds.

If the measurements of the three indicators in both sampling periods are compared, only one trend seems to emerge. The TOC concentrations in well numbers G-1, G-2, and G-4 seem to remain similar--an average of 28.4 mg/l, 20.7 mg/l, 23.8 mg/l in September and 98.8 mg/l, 117 mg/l, and 102 mg/l in October. (The TOX in all wells decreased from September to October but not consistently.) If this is a legitimate trend, the operations of Hukill Chemical are having little effect on TOC concentrations in the overall groundwater and the effects observed in samples collected from well number G-3 are localized.

7. SOURCE EVALUATION

The evaluation presented in Section 6 suggested that chloride is the only parameter in water leaving the Hukill Chemical facility that was consistently in excess of the EPA drinking water standard, and this occurred only in groundwater. Even though contamination is not currently leaving the facility, an evaluation has been made of existing sources that have the potential to become future sources of contamination.

7.1 Offsite versus Onsite Sources

Based on the evaluation discussed in Section 6, Table 12 was prepared to demonstrate the relative contributions of onsite and offsite sources to water quality leaving the site. The table includes only those parameters found leaving the site in excess of the EPA drinking water standards and those parameters for which no standard was available. The findings can be summarized as indicated below.

- o Lead was below the detection limit in both upgradient and three downgradient groundwater samples. One downgradient groundwater sample contained lead in excess of the EPA drinking water standard.
- o Chloride concentrations were found in excess of the EPA drinking water standard in all downgradient groundwater samples but were less than the standard in all upgradient samples.
- o There was no 1,1-dichloroethylene detected in upstream surface water or in upgradient and three downgradient groundwater samples. One downgradient groundwater sample contained 0.040 ppm and the downstream surface water samples contained 0.020 ppm and trace amounts of 1,1-dichloroethylene.
- o Upstream and downstream surface water samples contained 1.5 ppm and 4 ppm of acetone, respectively. The groundwater contained less than 0.5 ppm.

Table 12. Relative Contributions to Water Quality

Parameter ^a	EPA Standard/ SNARL ^b	Groundwater			Difference (Max.) ^c	Surface Water		
		Upgradient (G-1)	Downgradient (G-2)	Downgradient (G-3)		Upstream (S-B)	Downstream (S-C)	Difference (Max.) ^c
Lead (mg/l)	0.05	<0.05 <0.05	<0.05 <0.05	<0.05 0.10 ^d	> 0.05	<0.05 <0.05	<0.05 <0.05	-
Chloride (mg/l)	250	122 53	340 ^d 370 ^d	335 ^d 326 ^d	317	46 46	37 60	14
1,1-Dichloroethylene (ppm)	None	- -	- 0.040	- -	0.040	- -	tr ^e 0.02	0.02
Acetone (ppm)	None	<0.5 -	<0.5 -	<0.5 -	<0.5	1.5 -	4 -	2.5
Aliphatic Hydrocarbons (Low M,W) (ppm)	None	- -	0.01-0.05 0.05-0.10	tr ^e 0.01-0.02	<0.10	- -	- -	-
Chemical Oxygen Demand (mg/l)	None	62 17	25 230	225 176	213	102 13	98 79	85
Total Organic Carbon (mg/l)	None	28.4 98.8	20.7 117.0	389.5 248.0	361.1	20.0 31.1	31.2 39.2	19.2
Total Organic Halogen (mg/l)	None	0.025 0.021	0.066 0.043	0.063 0.028	0.045	0.066 0.102	0.303 0.252	0.237

Notes:

^a Only the parameters in excess of EPA standards or SNARLS or for which no recommended level is available are included.

^b See Tables 4, 5, 7 and 8.

^c Difference (max.) is result of subtracting the minimum upgradient/upstream concentration from the maximum downgradient/downstream concentration.

^d In excess of EPA standard/SNARL.

^e Trace, indicates greater than 1 ppb.

- Upgradient groundwater and all surface water samples contained no aliphatic hydrocarbons but downgradient groundwater contained up to 0.10 ppm.
- The COD in upgradient groundwater and upstream surface water samples was highly variable. In downgradient and downstream samples, COD was generally higher but below 250 mg/l.
- TOC was consistently higher in downstream surface water samples but was below the NPDES permit limit for the outfall. One downgradient well G-3 was consistently higher in TOC than the upgradient well.
- TOX was in the parts per billion range in all groundwater and surface water samples.

The above findings suggest that neither the single measurement of 0.10 mg/l of lead (the standard is 0.05 mg/l) in downgradient groundwater nor the single incidence of acetone in upstream and downstream surface water are highly significant. The concentrations of indicator parameters (COD, TOC, and TOX) seem to suggest little more than increased TOC in one downgradient well.

7.2 Groundwater

As indicated above, the total organic carbon is significantly higher in well number G-3. Since well number G-3 has been consistently described as having a hydrogen sulfide odor, this may be related to the elevated TOC although no direct means has been identified. In addition, a thin layer of residual grass was removed during drilling (see the well logs) and the decomposing of this organic matter (now exposed to oxygen) may be increasing the TOC. Most importantly, the groundwater leaving the site (monitored in wells number G-2 and G-3) is below the EPA Suggested No Adverse Response Levels for drinking water for the volatile organics detected.

It must be recognized that the estimated flow rate, derived in Section 5.2 using Darcy's Law, is a rough approximation and does not account for movement

through fractures in the shale bedrock. The estimated flow rate of 0.04 inches per year (0.3×10^{-3} feet per year) is typical of tight clays used as landfill liners. This flow rate has been further examined to estimate the travel time from the tank farm to well number G-3. It was assumed that liquids leaving the tank farm (either resulting from leakage or standing water) would travel down the slope of the erosion surface through the black silty clay (see Figure 7) containing cinders to the greenish gray clay containing shale fragments and roots. The permeability used (9.5×10^{-7} cm/sec) was the average of these two materials (see Table 3). The gradient used was that determined for the northern half of the site (0.08) and the porosity the average for skip-graded silty clay with rock fragments (0.335). Using this input, Darcy's Law provided estimates of a flow rate (0.23 feet per year) that is greater than the overall groundwater flow rate. However, the distance from the eastern tank farm to well number G-3 is approximately 100 feet and therefore the travel time would be in excess of 400 years.

7.2.1 Buried Cistern

An examination of Table 4 suggests that the concentrations of all inorganic parameters are less than the EPA drinking water standards. Although chloride levels exceed the drinking water standard in downgradient groundwater, chloride was measured at 26 mg/l in both samples from well number G-4; and therefore, the buried cistern does not appear to be the source of these chloride levels.

The field measurement of pH in well number G-4 in October (6.6) was just within the range for drinking water and had decreased from that measured in September (7.1). However, the September samples were measured in replicate in the laboratory and ranged from 6.7 to 7.1 with an average of 6.9.

Table 5 indicates that well number G-4 did not contain organic constituents in excess of the EPA SNARLS although many were present in trace amounts. Total organic carbon concentrations were similar to those in the upgradient groundwater (well number G-1) and total organic halogen concentrations were in the parts per billion range.

Table 13. Maximum Contributions by Selected Sources

Parameter ^a	Groundwater			Surface Water		
	Overall Difference ^a	Buried Cistern (G-4)	Tank Farm (NE Standpipe)	Overall Difference ^a	Outfall 001 (S-A)	Groundwater Runoff ^b
Lead (mg/l)	>0.05	0.05	<0.05	-	<0.05	-
Chloride (mg/l)	317	26	85	14	75	-
1,1-Dichloroethylene (ppm)	0.040	tr ^c	1	0.020	-	0.020
Acetone (ppm)	<0.5	<0.5	<100	2.5	20	-
Aliphatic Hydrocarbons (ppm)	<0.10	-	-	-	-	-
Chemical Oxygen Demand (mg/l)	213	22	3,510	85	203	-
Total Organic Carbon (mg/l)	361.1	102.0	1,800	19.2	92.9	-
Total Organic Halogen (mg/l)	0.045	0.112	-	0.237	5.28	-

Notes:

^a See Table 10.^b Groundwater runoff is result of subtracting the minimum concentrations in the outfall and upstream samples from the maximum concentrations in the downstream samples.^c Trace, indicates greater than 1 ppb.

An evaluation of the data in Table 13 suggests that the groundwater samples from well number G-4 contain such low concentrations of the parameters shown that it would appear that the buried cistern has no impact on overall groundwater quality.

7.2.2 Solvent Tank Farm

Three heavy metals were found in excess of the EPA drinking water standards and seven organic compounds in excess of the EPA SNARLS for drinking water. Both the water in the standpipes and the standing water within the solvent tank farm contained considerably higher levels of TOC than either the interceptor sewer or the outfall and chloride levels were a maximum of 85 mg/l. Although the low permeabilities of underlying materials has prevented the migration of these contaminants, approximately 9 feet of water was measured in the 10-foot standpipes in the corners of the solvent tank farm. Much of this volume can be attributed to stormwater but its organic nature is apparently the result of Hukill Chemical operations.

It is highly likely that some of the subsurface materials beneath the solvent tank farm may be saturated with solvents. The boring for well number G-4 (see Appendix A) and the results of permeability tests (see Table 3) suggest that the permeability of subsurface materials approximately 2.5 feet below the ground surface is 2.2×10^{-8} cm/sec. It seems reasonable to assume that these materials are causing the combined solvents and stormwater to be perched near the ground surface. Therefore, the 9 feet of water in the standpipes suggests that the saturated materials extend from just below the surface to approximately 2.5 feet deep and include the backfilled materials around the standpipes. This hypothesis accounts for standing water on the surface on some occasions and suggests that as the depth of water drops, this standing water will submerge. It also suggests that the maximum depth of perched water possible, without some surface indication of standing water, is less than 2.5 feet.

More importantly, since these standpipes were designed to act as sumps and collect the water within the tank farm, the annular space between the undisturbed materials and the standpipes is not sealed. Therefore, this area

provides a path to the groundwater system for the perched liquids found in the tank farm. Again, considering the groundwater flow rate, this is not likely to be detected in the downgradient wells for many years.

Table 13 indicates that the concentrations found in the vicinity of the solvent tank farm could account for all of the overall differences in groundwater quality except for chlorides. More importantly, the estimated groundwater flow rates suggest that the quality of water currently leaving the property is not effected by Hukill Chemical operations.

This study was not designed to determine if the source of the contaminants is one or more leaking tanks. However, discussions with Hukill Chemical personnel suggest that the tanks are allowed to overflow on occasion and this may be the major source of contamination.

7.2.3 Groundwater Runoff

Since 1,1-dichloroethylene is the only parameter listed in Table 13 that is not found in the outfall, there are no other apparent contributions to surface water quality from groundwater runoff. Since this parameter was only found in trace amounts, in downstream samples, in September, it may not be significant. However, its presence in groundwater at the facility suggests that it may be the result of Hukill Chemical operations.

7.3 Outfall 001

It should be noted that it was not a goal of this study to evaluate the quality of outfall 001 and therefore the parameters measured were those indicative of groundwater quality--that is, the volatile organic compounds.

Some of the concentrations of organic compounds decreased in October, probably as a result of pumping the API Separator. A comparison of the data in Table 8 and in Table 10 indicates that these parameters are increasing in November and may continue to increase until the levels measured in September are reached. As can be seen from Table 13, the quality of outfall 001 could account for all overall differences between upstream and downstream water quality except for 1,1-dichloroethylene.

Acetone was measured at 20 ppm on September 23 and at 8 ppm on October 21 in the outfall and was only 1.5 ppm and undetected on the same dates in upstream water. In September, the downstream concentration of acetone was 4 ppm; and therefore, it can be assumed that the 20 ppm concentration in the outfall produced an increase of 2.5 ppm in the stream at the downstream sampling point. Since there is no recommended level for acetone, there is no means of determining if a level of 4 ppm is excessive. However, the acetone in surface water had dropped below the detection limits by October, so the September reading may not be significant.

The range of TOC concentrations in September was 51.1 mg/l to 54.2 mg/l and the single measured concentration in October was 92.9 mg/l and 112 mg/l in November. Clearly, the October and November concentrations were over the allowable NPDES permit limit of a maximum of 90.0 mg/l. The maximum TOX contribution to the stream (0.237 ppm) occurred in September when the TOX in the outfall was 5.28 ppm. In September when the COD in the outfall was 160 mg/l and the upstream water quality was 102 mg/l, the outfall had no effect on the downstream concentration (98 mg/l). However, when the upstream COD dropped to 13 mg/l in October and the outfall increased to 203 mg/l, the downstream concentration was 79 mg/l.

7.3.1 Interceptor Sewer

Since additional samples were being collected for the solvent tank farm in November, the interceptor sewer was sampled before it entered the API Separator. This flow is largely the result of flows from the catch basin in the truck unloading area nearby. Most of the organic constituents were found in low concentrations, but there were a large number of organic compounds present.

Since the API Separator acts as a holding tank and a portion of the flow to outfall 001 is stormwater runoff, the concentrations in the interceptor sewer cannot be directly compared to those in the outfall. However, on November 18 neither contained inorganic constituents in excess of the EPA drinking water standards; and, the chloride levels were 34 mg/l in both.

Xylenes were present in each of the outfall samples but were not detected in the single interceptor sewer sample. Ethylbenzene was detected in the last outfall sample but not in other outfall samples or the interceptor sewer sample. The acetone concentration in the interceptor sewer was the same as in the outfall. Total organic carbon was higher in the outfall than in the interceptor sewer.

7.3.2 Stormwater Runoff

No samples of stormwater runoff were collected; however, the evaluation of the relationship of interceptor sewer water quality to outfall water quality suggests that stormwater runoff may also be a source.

Stormwater runoff is collected from roof gutters and from collection basins in parking areas and is discharged directly to outfall 001. Considering that the TOC level in November is higher in the outfall than in the interceptor, the stormwater collection system must have contained levels of TOC in the range of 100 mg/l. Since there is no reason to believe that these levels are related to the operation of Hukill Chemical, samples should be taken of the stormwater runoff to determine if this is actually a source. If so, it may not be possible to meet the NPDES effluent limits during periods of continued rainfall.

3. Steps should be taken to remove the source of the contaminants in the solvent tank farm. A means to prevent overtopping of the tanks should be implemented as well as a means of evaluating if any of the tanks may be leaking. Considering the spacing of the tanks, the determination of whether one or more tanks is leaking is not feasible through the use of a monitoring well program. Such a determination will have to be based on monitoring liquid levels in the tanks.
4. *Leon's* A process engineering study may be needed to determine the overall effectiveness of the API Separator. Samples of water from various places within the system may be necessary in order to make this determination.
5. Since the buried cistern is no longer being used in Hukill Chemical operations, it is recommended that it be dewatered and filled with low permeability materials. If it is physically removed, the hole should be filled with compacted low permeability materials or it may become a collection point for contaminants.
6. There appears to be no reason for installation of a well point in this area.
7. The monitoring program should be continued on a periodic basis to ascertain that concentrations of contaminants leaving the facility do not increase. Considering the slow rate of groundwater flow, annual samples for the same parameters evaluated in this study are recommended.

APPENDIX A

WELL LOGS

NUS WELL RECORD

Project: Hukill Chemical
 Well No.: G-1
 Coordinates: See Figure 1
 On-Site Geologist: D. Wallace
 Elevation (top of pipe): 982.34
 Elevation (land surface): 979.36
 Elevation (water table): 963.51
 Date Measured: 9/15/82
 Status of Well: Complete

DRILLING

Drilling Started: 9/15/82
 Drilling Completed: 9/15/82
 Drilling Company: Triggs & Assoc.
 Registration No.: None
 Permit No.: None Needed
 Name of Driller: Harry Grasser
 Type of Rig: Rotary (Hollow stem)
 Drilling Fluid: None

HOLE DATA

Hole Diameter: 7 in.
 Thickness of Overburden: 9 ft.
 Depth Drilled in Rock: 19 ft.
 Total Depth of Hole: 28 ft.

DEVELOPMENT

Method: Surging with air
 Rate of Flow: 3 min. recovery
 Length of Time: 25 min.

CASING

Type: 304 Stainless Steel (Sch. 5)
 Diameter: 2 in. ID
 Length: ~ 30.92 ft. (Total)
 Type of Joint: Threaded (flush)
 Screen Slot: #7 (0.007 in.)
 Screen Length: 10 ft.
 Screen Setting: 17.5 ft. to 27.5 ft.
 Stickup: 35.75 in.

GRAVEL

Type: Silica
 Size: Pea gravel with some sand
 Volume: ~ 30 gal.
 Depth: 10 ft. to 28 ft.

GROUT

Type: Bentonite (Powder)
 Method: Poured
 Volume: ~ 250 lbs.
 Depth: 2 ft. to 10 ft.

BACKFILL

Type: None (see above)
 Cement Collar: 2 ft.

COMMENTS

Perm. Test - 8.5-10ft. - Top
 WL - 9/15 - 11:00 am - 18.83 ft.

DRILLING LOG

From	Depth To	Formation Description
	0 - 3 ft.	Black sandy clay
	3 ft. - 5 ft.	Gold sandy clay - Greenish gray solution veins - Some red clay chunks
	5 ft.	Small boulder of greenish gray shale
	5 ft. - 6.5 ft.	Gold sandy clay as above
	6.5 ft. - 9 ft.	Gold silty clay - laminated
	9 ft. - 14 ft.	Highly weathered greenish gray shale
	13 ft.	Water (small seep)
	14 ft. - 23 ft.	Shale - Greenish gray - Fracture well defined - Poorly cemented
	23 ft. - 28 ft.	Shale - Greenish Gray - Well cemented
	28 ft.	BOH

NUS WELL RECORD

Project:	Hukill Chemical
Well No.:	G-2
Coordinates:	See Figure 1
On-Site Geologist:	D. Wallace
Elevation (top of pipe):	979.29
Elevation (land surface):	975.87
Elevation (water table):	953.38
Date Measured:	9/15/82
Status of Well:	Complete

DRILLING

Drilling Started: 9/13/82
Drilling Completed: 9/14/82
Drilling Company: Triggs & Assoc.
Registration No.: None
Permit No.: None Needed
Name of Driller: Harry Grasser
Type of Rig: Rotary (Hollow stem)
Drilling Fluid: None

HOLE DATA

Hole Diameter: 7 in.
Thickness of Overburden: 28 ft.
Depth Drilled in Rock: 5 ft.
Total Depth of Hole: 33 ft.

DEVELOPMENT

Method: Surging with air
Rate of Flow: No removal
Length of Time: 15 min.

CASING

Type: 304 Stainless Steel (Sch. 5)
Diameter: 2 in. ID
Length: ~ 36.16 ft. (Total)
Type of Joint: Threaded (flush)
Screen Slot: #7 (0.007 in.)
Screen Length: 10 ft.
Screen Setting: 22.5 ft. to 32.5 ft.
Stickup: 41.05 in.

GRAVEL

Type: Silica
Size: Pea gravel with some sand
Volume: ~20 gal.
Depth: 21 ft to 33 ft.

GROUT

Type: Bentonite (Powder)
Method: Poured
Volume: ~ 400 lbs.
Depth: 2 ft. to 21 ft.

BACKFILL

Type: None (see above)
Cement Collar: 2 ft.

COMMENTS

Perm. Test - 23-25 ft. - Bottom
 WL - 9/14 - 12:30am - 25.95 ft.
 WL - 9/15 - 8:40am - 25.91 ft.

DRILLING LOG

[illegible]

NUS WELL RECORD

Project: Hukill Chemical
 Well No.: G-3
 Coordinates: See Figure 1
 On-Site Geologist: D. Wallace
 Elevation (top of pipe): 979.53
 Elevation (land surface): 977.03
 Elevation (water table): 954.45
 Date Measured: 9/15/82
 Status of Well: Complete

DRILLING

Drilling Started: 9/13/82
 Drilling Completed: 9/13/82
 Drilling Company: Triggs & Assoc.
 Registration No.: None
 Permit No.: None Needed
 Name of Driller: Harry Grasser
 Type of Rig: Rotary (Hollow stem)
 Drilling Fluid: None

HOLE DATA

Hole Diameter: 7 in.
 Thickness of Overburden: 28 ft.
 Depth Drilled in Rock: 14 ft.
 Total Depth of Hole: 42 ft.

DEVELOPMENT

Method: Surging with air
 Rate of Flow: 5 min. recovery
 Length of Time: 25 min.
 Strong methane smell

CASING

Type: 304 Stainless Steel (Sch. 5)
 Diameter: 2 in. ID
 Length: ~ 44.16 ft. (Total)
 Type of Joint: Threaded (flush)
 Screen Slot: #7 (0.007 in.)
 Screen Length: 10 ft.
 Screen Setting: 31.5 ft. to 41.5 ft.
 Stickup: 30.05 in.

GRAVEL

Type: Silica
 Size: Pea gravel with some sand
 Volume: ~ 25 gal.
 Depth: 24 ft. to 42 ft.

GROUT

Type: Bentonite (Powder)
 Method: Poured
 Volume: ~ 300 lbs.
 Depth: 2 ft. to 24 ft.

BACKFILL

Type: None (see above)
 Cement Collar: 2 ft.

COMMENTS

Perm. Test - 18.5 ft - 20 ft. - Top
 and 23.5 - 25 ft. Bottom
 WL - 9/14 - 9:45am - 25.08 ft.
 WL - 9/15 - 8:30am - 25.08 ft.

DRILLING LOG

From	Depth	To	Formation Description
	0 - 15 ft		Fill - Silty clay - Upper layer black, followed by rust, then brown - Some roots and cinders
	15 ft. - 15.5 ft.		Residual grass zone - black but still distinguishable - Damp
	15.5 ft. - 24 ft.		Greenish gray silty clay with shale fragments and wood chips
	24 ft. - 28.5 ft.		Black clay - Organic looking with wood chips
	28 ft.		Water (small seep)
	28.5 ft. - 30 ft.		Highly weathered greenish gray shale
	30 ft. - 35 ft.		Shale - Greenish gray - Poorly cemented
	35 ft. - 42 ft.		Shale - Greenish gray - Well cemented
	42 ft.		BOH

NUS WELL RECORD

Project: Hukill Chemical
Well No.: G-4
Coordinates: See Figure 1
On-Site Geologist: D. Wallace
Elevation (top of pipe): 980.55
Elevation (land surface): 979.17
Elevation (water table): 970.55
Date Measured: 9/15/82
Status of Well: Complete

DRILLING

Drilling Started: 9/14/82
Drilling Completed: 9/14/82
Drilling Company: Triggs & Assoc.
Registration No.: None
Permit No.: None Needed
Name of Driller: Harry Grasser
Type of Rig: Rotary (Hollow stem)
Drilling Fluid: None

HOLE DATA

Hole Diameter: 7 in.
Thickness of Overburden: 8.5 ft.
Depth Drilled in Rock: 9.5 ft.
Total Depth of Hole: 18 ft.

DEVELOPMENT

Method: Surging with air
Rate of Flow: 5 min. recovery
Length of Time: 15 min.

CASING

Type: 304 Stainless Steel (Sch. 5)
Diameter: 2 in. ID
Length: ~ 19.33 ft. (Total)
Type of Joint: Threaded (flush)
Screen Slot: #7 (0.007 in.)
Screen Length: 10 ft.
Screen Setting: 7.5 ft. to 17.5 ft.
Stickup: 16.55 in.

GRAVEL

Type: Silica
Size: Pea gravel with some sand
Volume: ~ 18 gal.
Depth: 6 ft. to 18 ft.

GROUT

Type: Bentonite (Powdered)
Method: Poured
Volume: ~ 200 lbs.
Depth: 2 ft. to 6 ft.

BACKFILL

Type: None (see above)
Cement Collar: 2 ft.

COMMENTS

Perm. Test - 3.5 - 5 ft. - Bottom
WL - 9/15 - 8:15am - 10.0 ft.

DRILLING LOG

[illegible]

APPENDIX B
STATISTICAL DATA

STATISTICAL DATA FOR TOC

Sample Point: G-1
No. of Samples: 4
Mean: 28.4
Variance: 73.26

Sample Point: G-2
No. of Samples: 4
Mean: 20.7
Variance: 1.96

Sample Point: G-3
No. of Samples: 4
Mean: 389.5
Variance: 443.66

Sample Point: G-4
No. of Samples: 4
Mean: 23.8
Variance: 2.55

Sample Point: S-A
No. of Samples: 4
Mean: 52.8
Variance: 2.67

Sample Point: S-B
No. of Samples: 4
Mean: 20.0
Variance: 14.20

Sample Point: S-C
No. of Samples: 4
Mean: 31.2
Variance: 10.13